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SCIENCE

10 July 1959

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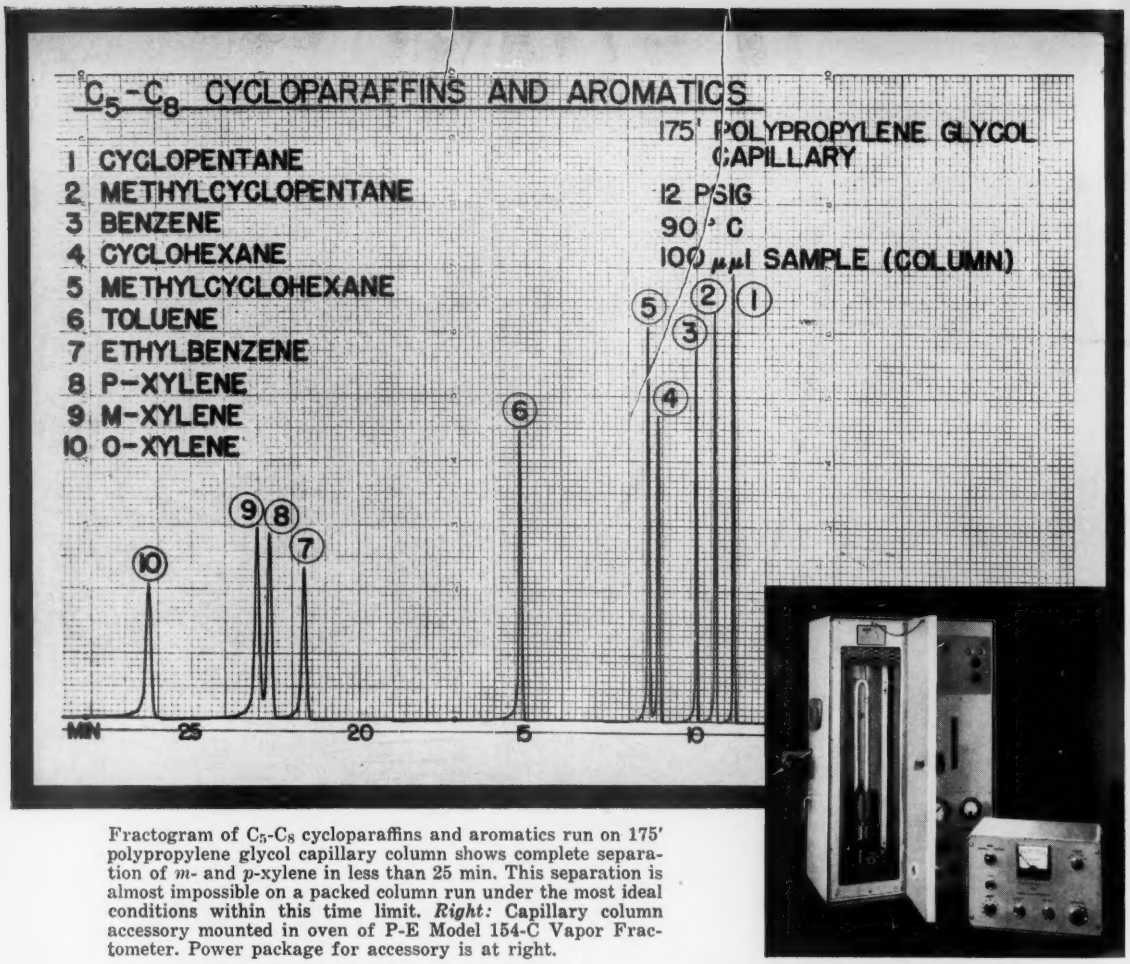

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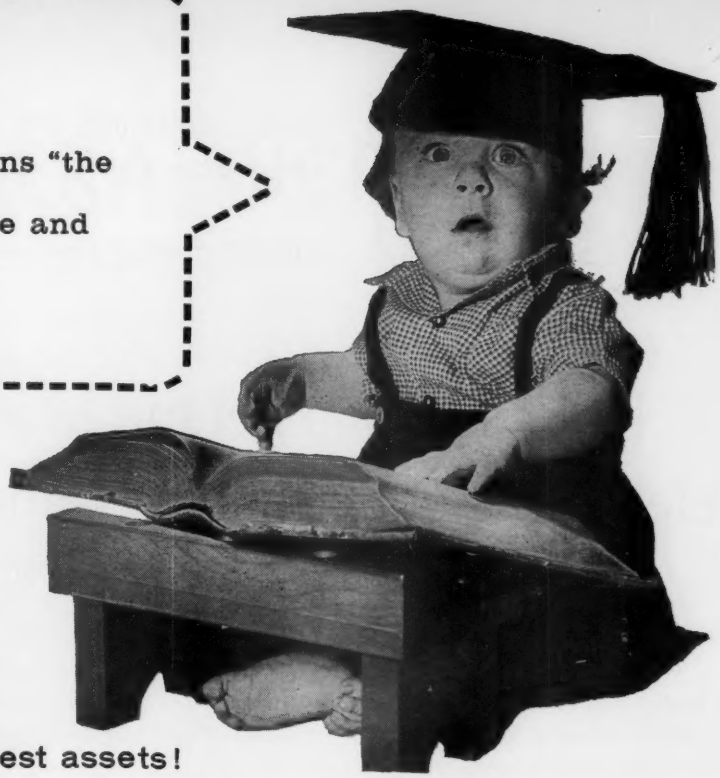

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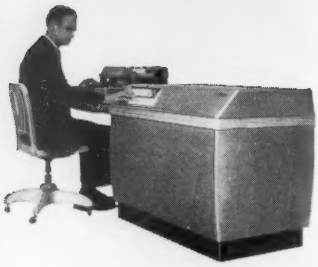

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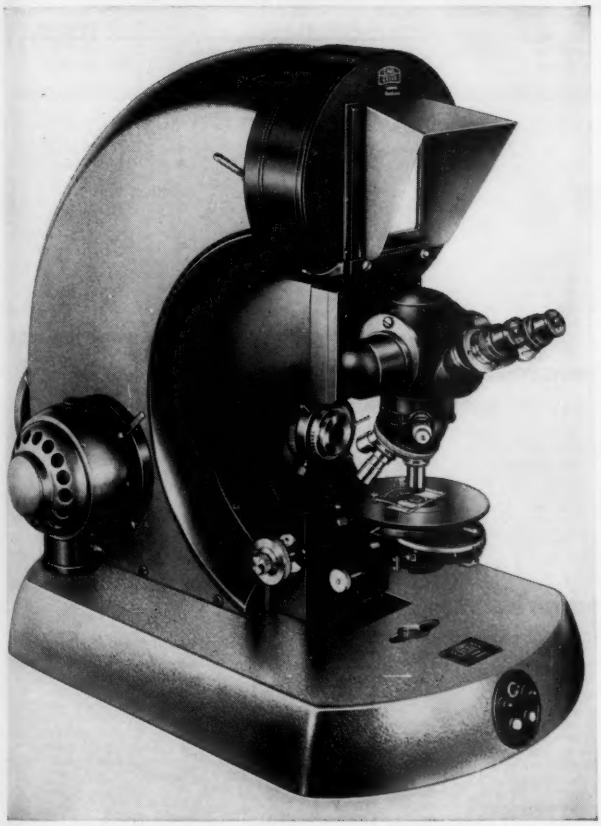

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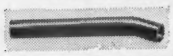

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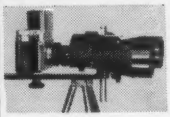

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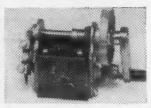

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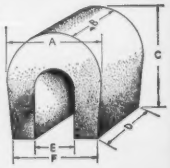

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by Dr. Vincent William Howard

Director of Advanced Systems Engineering, Radioplane Division, Northrop Corporation

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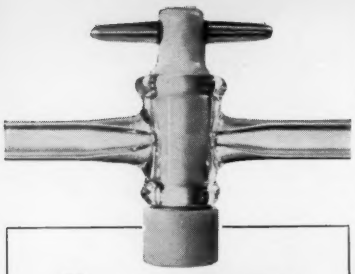

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Letters

Private Spending for Science

I hold a view that differs from that of P. W. Hutson [*Science* **129**, 1369 (1959)]. In my opinion private expenditures for scientific or educational institutions for public welfare have, on the whole, done more good than comparable expenditures by the Federal Government. In short, I believe a man expending money that he himself has earned will usually do a better job than a politician expending someone else's money; there is more objective consideration of real human welfare, less influence of human selfishness.

That "disaster could overtake us" is more likely to follow from unwise government expenditure than from unwise private expenditure. In Russia at present the "primacy of the larger society" is nearly absolute. I think it should be lessened if not "undermined."

PAUL W. MERRILL
1380 New York Drive,
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Teaching and Research

A point of fundamental importance was raised by Edmund M. Spieker [*Science* **129**, 1324 (1959)] in his answer to Fourman's earlier letter on the undervaluation of teaching ability in comparison with research performance, as measured by publications, in the evaluation of college professors. The point he makes, and seems to accept as an established fact, is that teaching ability cannot exist without the stimulus of research. Furthermore, he specifically applies this thesis to undergraduate college teaching.

It is not my intention to argue this point, but I do wonder whether it has ever been proved. Whether or not one can recall excellent but "unproductive" professors from his college days is probably not pertinent, but it is strange that scientists will make a statement like Spieker's without presenting a scrap of supporting evidence. He says that in all the literature that he has read "on this troublesome subject" there is little or no mention of this matter. As a matter of fact, I have heard the "troublesome subject" resolved in Spieker's way many times; perhaps it is all right to say such things without documenting them.

Many years ago a project (participated in by the AAAS) seemed to demonstrate that the undergraduate background most likely to lead to the doctorate in science is to be had in small colleges. Is it possible that the professors in such institutions are more active in research than those in large universities, and is the impression some of us hold that the professors in small schools are not very active "publishers" wholly incorrect?

Until a relationship has actually been demonstrated it is not safe to assume on philosophical grounds alone that good teaching necessarily depends on whether the teacher is actively engaged in research. This is an important point to resolve because many potentially excellent teachers *may* be doing less than their best teaching in an effort to satisfy the university administration by doing research—research that may very well needlessly add to the volume of scientific publications. In some fields, at least, we could profit by fewer but more significant publications.

JESSE D. RISING
Department of Postgraduate Medical Education, School of Medicine, University of Kansas Medical Center, Kansas City

"Personal Liberties" Threatened?

In the News of Science section [*Science* **129**, 625 (1959)], headed "Loyalty Provisions of National Defense Education Act Meet Opposition from Educators and Congressmen," were published quotations from a letter signed by the president and general secretary of the American Association of University Professors. The part that especially irked me was, " 'the Act seems to say to members of the educational community: ". . . you are a particularly suspect part of the population and will have to pass a special test that other citizens need not take." ' "

I do not see why *they* should feel picked on. After all, there are a few million citizens in military and civil service who take oaths of allegiance and every few months are asked to check the attorney general's list of subversive organizations to make sure they have not inadvertently fallen into the clever trap of the communists, who organize or infiltrate organizations with the most innocent and patriotic sounding names. One may, of course, think that those in the U.S. military or civil service take loyalty oaths because they receive money from the government. The National Defense Education Act will also give government money to those successful applicants who are asked to take the oath and sign the disclaimer affidavit. Not that I believe for one moment that the requirement of taking an oath is going to deter a real communist from doing *anything*, but I do believe signing the disclaimer affidavit may alert an unsuspecting youth to communist psychological warfare tactics. It may even prevent him from innocently becoming so involved in suspect organi-

(*Continued on page 106*)

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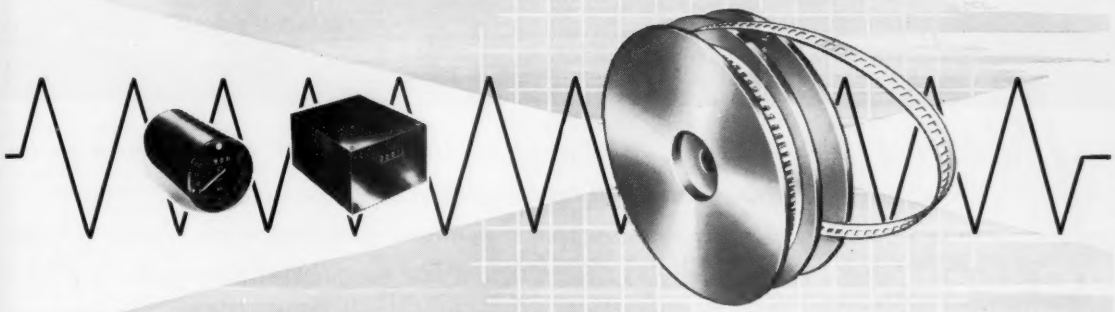

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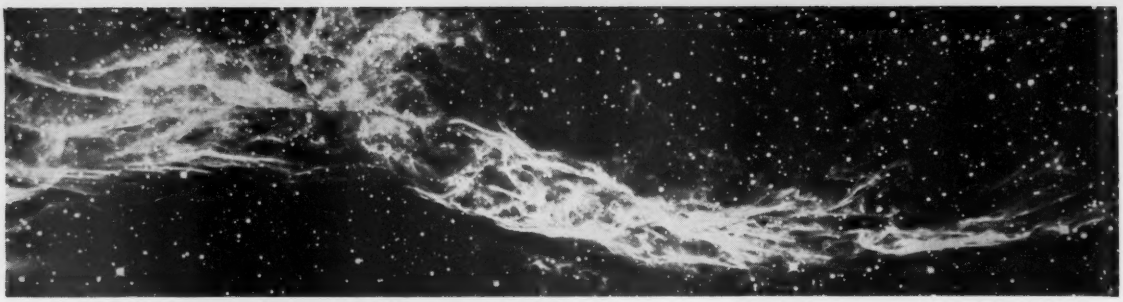

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Oaths and Disclaimers

On 24 June the Senate Labor and Public Welfare Committee reported the Kennedy-Clark bill (S 819), a bill that would eliminate from the National Defense Act of 1958 the section that requires a teacher or a student who applies for a loan or a grant under the provisions of the bill to sign an oath of loyalty and an affidavit that "he does not believe in, and is not a member of and does not support any organization that believes in or teaches, the overthrow of the United States Government by force or violence. . . ."

What will happen to the bill now is anybody's guess. The action of the committee in reporting it put it on the Senate calendar, but it will not come up for a vote unless the Senate majority leader, Lyndon Johnson, decides to put it on the agenda.

In the hearings on the bill (a copy of the testimony may be obtained from your senator) the great majority of those who testified—the secretary of the Department of Health, Education, and Welfare and representatives of the American Council on Education, the Association of American Colleges, and the American Association of University Professors, among others—strongly favored elimination of the disclaimer affidavit. Opinion about the loyalty oath was divided: some thought it perfectly proper, some thought it proper but ineffective and cumbersome to administer, and some thought it improper in that it singled out students and teachers as a special class whose loyalty was impugned. Those who felt this most strongly wondered why other recipients of government aid—farmers, veterans, bankers, airline operators, and so on—were not also required to take a loyalty oath.

The middle position was represented by those who were willing, in some cases reluctantly, to let the loyalty oath stand but who were strongly in favor of eliminating the affidavit or disclaimer oath. Thus, both the American Association of University Professors and the Association of American Colleges, as well as many individuals, agreed that the disclaimer was undesirable. It was objected to, as was the loyalty oath by some, for discriminating against teachers and students, for being superfluous if the loyalty oath were retained, for being a "test oath" of opinion reminiscent of the religious and political test oaths of bygone ages, and for being vague (what organizations one is supposed not to "believe in" is nowhere specified) and possibly unconstitutional.

The arguments advanced against the disclaimer oath on the basis of principle are somewhat subtler. They center around the importance of trust in the educational process and in democracy. Fairly representative of this stand is the comment of the American Association of Colleges to the effect that the disclaimer affidavit created "apprehension and timorousness on college and university campuses" and that the "real security of the country lies in the maintenance of freedom of spirit as well as in fact, and that democracy depends upon trust in the individual. . . ."

This is a good and moderate statement, but it does not go far enough. Neither the oath nor the disclaimer is going to give pause to anyone who is disloyal to the country. Thus both are ineffective and impose unnecessary financial and administrative burdens on the colleges and the government. We agree with Secretary Flemming and others that the oaths are unnecessary, that our present security laws provide adequate safeguards, and that anyone who violates them "should be prosecuted immediately under the laws designed directly and specifically for such offenses."—G.DuS.

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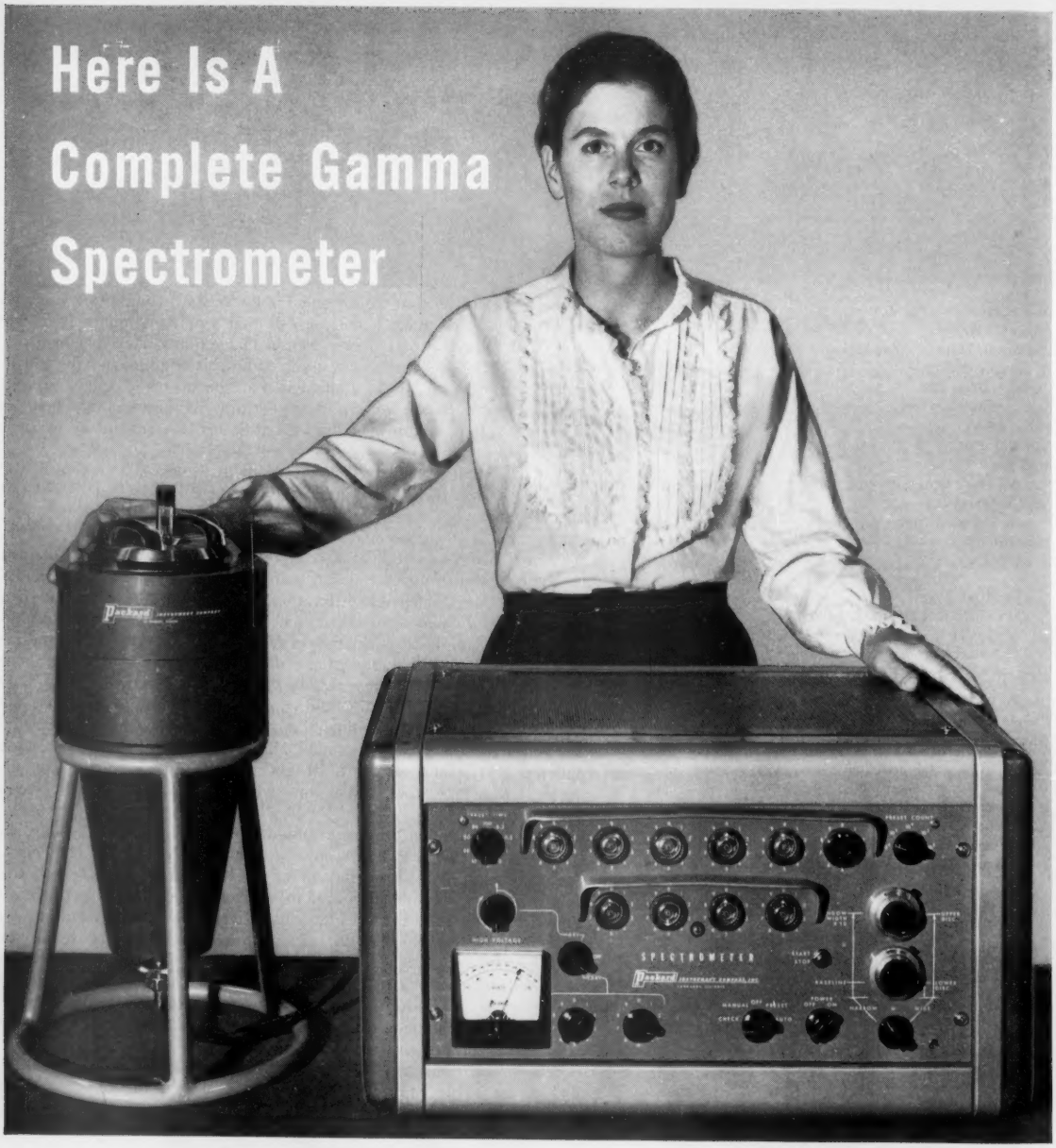

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College Environments and the Development of Talent

Characteristics of colleges are related to the percentage of graduates who attain the Ph.D.

Donald L. Thistlethwaite

The hazards of ranking colleges with respect to the quality of undergraduate instruction are well known. Recently a number of investigators have stressed the need for a method of controlling differences in student quality among institutions so that comparisons of institutions on the basis of the attainments of their graduates will not be affected by diversities in their talent supplies. In this article (*1*), measures of the relative success of colleges in stimulating their students to attain the Ph.D. have been adjusted to remove the effects of differences in the intellectual caliber of the student bodies. Two indices of Ph.D. productivity have been developed—one for the natural sciences and one for the arts, humanities, and social sciences—and these indices have been related to various college characteristics, including type of program and student body, geographical location, and student reports of faculty and administrative behavior.

The analysis tests and affirms the general hypothesis that the nature of contacts between undergraduate students and faculty partly determines whether or not the student will seek advanced training. Student observations of faculty behavior indicate that the teacher who stimulates students to enter graduate study is distinguished by certain attitudes and actions. Furthermore, faculties which inspire achievement in the natural sciences have traits that are different from those of faculties which stimulate achievement in the arts, humanities, and social sciences.

Since previous indices for assessing college productivity failed to take into account diversities in supplies of college talent, they cannot be regarded as accurate estimates of educational effectiveness. Several investigators (*2*) have pointed out that some institutions get a higher proportion of talented students than others, and so should be expected to have a higher proportion of their graduates attain Ph.D.'s. The Knapp and Goodrich (*3*) and the Knapp and Greenbaum (*4*) indices, as well as Traxler's (*5*) rankings of American colleges according to the percentage of their male graduates listed in *Who's Who in America*, suffer from this limitation.

The seriousness of the errors introduced by ignoring diversities in the intellectual ability of different student bodies seems to vary with the type of productivity assessed. As is shown below, the percentage of a college's freshman class who are finalists in the National Merit Scholarship competition is a good index of the college's supply of talent. Assuming that diversities in college talent supplies remain relatively the same over a period of years, we may use this index to estimate student quality for the periods during which the Ph.D.'s identified in recent studies (*3, 4*) were undergraduates. The Knapp-Goodrich index of science productivity correlates .38 with this talent supply index, a figure consistent with the .39 reported by these authors as the correlation coefficient between their index and American Council of Education Scholastic Aptitude Examination score averages for 50 colleges. On the other hand, the talent supply index correlates .71 and .64, respectively with the male and female indices of productivity devised by Knapp and Greenbaum. Variations in student quality appear to account for 40 or 50 percent of the variance in the Knapp-Greenbaum indices, which are composite measures of scholarly and scientific productivity, and for approximately 15 percent of the variance in the Knapp-Goodrich index of science productivity. In short, the errors which result from overlooking diversities in talent supply seem to be greater for scholarly than for scientific indices.

New Productivity Indices

The first two annual National Merit Scholarship Programs, which provide records of the college enrollments of over 9600 talented students throughout the nation, offer one means of attacking the problem of equating colleges with respect to talent supplies so that valid comparisons of their effectiveness can be made. For freshman men attending 39 colleges, the correlation between mean scores on the College Entrance Examination Board Scholastic Aptitude Test (SAT) and the percentage of the freshman class who were Merit finalists was .74; for freshman women attending 43 colleges, the correlation between mean SAT scores and this percentage index was .76 (*6*). These estimates of validity are probably conservative, since College Board schools for which SAT scores are available tend to attract su-

The author is associate director of research, National Merit Scholarship Corp., Evanston, Ill., and lecturer in psychology at Northwestern University, Evanston.

perior students, and consequently the range of talent is narrower than that which would be found in a more representative sample of colleges.

In using the percentage of the freshman class who were Merit finalists as the talent supply index, I have assumed that the quality of the college's talent supply and the behavior of its faculty do not vary greatly over a 10- to 15-year period. Evidence bearing on the second assumption is not available, but there is some correlational evidence to support the first (*7*).

The index was used to estimate the supplies of student talent of 511 colleges during the period 1939–45. (Although only 4-year institutions attended by one or more Merit finalists during the first two years of the Merit Program are included, these 511 colleges enrolled about 70 percent of the total number who entered 4-year colleges or universities in 1956 and 1957.) The number of each college's graduates who, after receiving their bachelor's degrees, earned doctorates in the years 1950–56 inclusive was determined from data collected by the National Academy of Sciences–National Research Council (*8*). Since the median lapse between baccalaureate and science doctorate degrees is about 7 years, the number of graduates from each college was estimated for the period 1943–49 (*9*). The percentage of each college's graduates who went on to get the doctorate was then estimated by dividing the number of Ph.D.'s who did their undergraduate work at the college by the estimated number of graduates from that college during the selected time intervals.

The analysis yielded two adjusted productivity measures, one for the natural sciences and one for the arts, humanities, and social sciences. (Since the two measures will be frequently referred to, it is convenient to use "NS" and "AHSS" as code words for the two broad fields of endeavor.) The productivity indices are the discrepancies between a school's expected rate of Ph.D. productivity (NS or AHSS), as predicted from its enrollment of talented students, and its actual rate of productivity (*10*). Figures for a particular school indicate the relative success of that school in stimulating its undergraduates to get Ph.D.'s of a given type, the rating of success being independent of the quality of the student body.

Because of the extrapolations used, the measures are not sufficiently reliable to permit comparison of individual institutions. However, several lines of evidence indicate that the indices have substantial validity for groups of colleges. First, according to students' reports, there is a clear difference between productive and unproductive institutions in emphasis upon preparation for graduate study. Second, the measures appear to be sensitive to differences in institutional objectives. As might be expected, professional and technical schools rank highest in NS productivity, but are lowest in AHSS productivity. Similarly, 96 and 61 percent of the student informants attending institutions ranking "high" and "low," respectively, on the AHSS index endorse the statement: "The library is exceptionally well equipped with journals, periodicals, and books in the social sciences." Third, institutions located in the South tend to rank low on both measures, a finding which is consistent with previous research (*4*).

Table 1. Ph.D. productivity of undergraduate programs by type of institution. In this table, and those which follow, a numerically low index indicates high productivity. Numbers in parentheses are ranks based upon mean productivity indices.

Institutions*		Adjusted productivity index			
		Natural sciences		Arts, humanities, and social sciences	
Type	No.	Mean	S.D.	Mean	S.D.
Professional or technical schools	28	173 (1)	28.7	214 (7)	18.3
Men's colleges and universities	52	181 (2)	24.2	164 (3)	27.2
Women's colleges and universities	66	236 (7)	20.2	199 (6)	24.0
Coeducational institutions					
Private colleges	155	194 (4)	26.6	161 (1)	26.9
Public colleges	63	206 (6)	29.0	164 (2)	30.3
Private universities	64	197 (5)	19.2	170 (4)	24.8
Public universities	80	183 (3)	18.2	175 (5)	17.1
Total	508				
F-ratio		43.5		32.4	
Probability		$< .01$		$< .01$	

* The source used in classifying institutions was: U.S. Department of Health, Education, and Welfare, *Education Directory, 1956–57: Part 3, Higher Education* (U.S. Govt. Printing Office, Washington, D.C., 1956). "Universities" in this table include only those institutions which have three or more professional schools, as well as a liberal arts and general program. Professional and technical schools include only those listed as offering a professional or technical program, except Rice Institute and Massachusetts Institute of Technology, which were classified with the technical schools. Colleges with co-ordinate student bodies were classified as coeducational institutions. Three institutions (Peabody Conservatory of Music, Curtis Institute of Music, and Philadelphia Museum School of Art) were not classified.

Table 2. Ph.D. productivity of institutions classified by geographical position. The geographical classification described by Knapp and Goodrich (*2*) is used here. One institution (University of Puerto Rico) is not classified. Numbers in parentheses are ranks based upon mean productivity indices.

Geographical position	No. of institutions	Adjusted productivity index			
		Natural sciences		Arts, humanities, and social sciences	
		Mean	S.D.	Mean	S.D.
New England	32	191 (1)	28.5	171 (2)	25.5
Atlantic Seaboard	117	196 (4)	32.5	174 (3)	32.0
Middle West	185	195 (3)	27.3	167 (1)	28.6
Far West	65	191 (2)	31.6	175 (4)	29.8
South	111	210 (5)	27.2	182 (5)	27.4
Total	510				
F-ratio		6.36		5.18	
Probability		$< .01$		$< .01$	

Kind and Location of Institutions

Table 1 compares the extent to which different types of institutions stimulate their undergraduate students to seek the Ph.D. Differences between the mean productivity indices of different types of undergraduate programs are statistically

significant for both NS and AHSS measures.

Cultural values and norms which discourage women from seeking the Ph.D. may account for the relatively poor showing of women's colleges and universities. The specialized character of the curriculum and student goals at professional and technical schools is reflected in the fact that these schools rank highest in NS productivity and lowest—even below women's colleges and universities—in AHSS productivity. Men's colleges and universities, which have the advantage of a student clientele for whom graduate study is culturally approved, rank relatively high on both measures. In view of their coeducational student bodies, publicly supported universities are outstandingly productive of Ph.D.'s in the natural sciences.

Table 2 shows that geographical location is significantly related to productivity, and that institutions located in the South rank lowest on both the NS and AHSS measures. The differences between the mean indices of the four remaining regions are not statistically significant for either measure. Although Knapp and Greenbaum (*4*) did not adjust their indices for differences in talent supplies, their results, like mine, place institutions located in the South at the bottom in productivity. These results are not in accord with the geographical differences reported by Knapp and Goodrich, who found, after making adjustments for student quality, that in a small sample of 50 colleges the Middle and Far West ranked highest, the South was intermediate, and the Middle Atlantic and New England regions ranked lowest in science productivity. The small number of colleges makes it difficult to draw any conclusions from the latter analysis.

Protestant institutions tend to stimulate a greater proportion of their graduates to seek the Ph.D. than Catholic institutions do (Table 3). Since the possession of a religious affiliation by a college is negatively related to NS productivity and unrelated to AHSS productivity (Table 4), the standing of Catholic schools can probably be attributed to factors indigenous to the Catholic college or its student body, rather than to any positive motivating influence on the part of Protestant colleges. These differences in Ph.D. productivity might be due to teaching practices, parental values, or to the initial goals and career motivations of the students.

Table 4 shows that possession of a coeducational student body is the college characteristic most closely related to productivity. To be sure, the unproductivity of women's colleges and universities tends to depress the average for all noncoeducational institutions and so to make schools with coeducational student bodies look much more productive. However, in spite of their advantage in having an all-male clientele, men's colleges and universities are not significantly more productive in the arts, humanities, and social sciences than coeducational institutions. Thus, the high standing of coeducational schools suggests that a mixed student body may be favorable to the development of motivation to seek advanced degrees in these fields.

The only other college characteristic related to both measures of productivity is the number of volumes in the institution's library. It is not surprising that schools with larger libraries tend to be more productive, since it is likely that superior faculties and resources will be found at such institutions.

The remaining correlations in Table 4 suggest that natural science Ph.D.'s tend to come from a different set of baccalaureate institutions than do Ph.D.'s in the arts, humanities and social sciences. NS productivity is associated with large freshman enrollments, graduate programs offering the Ph.D., public support, and absence of religious affiliation. These characteristics are typical of the state university, which, as we have already noted, tends to be outstandingly effective in stimulating achievement in the natural sciences.

It is more difficult to characterize institutions which are productive of Ph.D.'s in the arts, humanities and social sciences. They tend to be located in small cities, and—contrary to expectation—to have relatively large numbers of students per faculty number. Student-faculty ratios are notoriously difficult to interpret. One would expect that the ratios for colleges would be smaller than those for universities. However, this is not the case for coeducational institutions in the present sample. No doubt, part of the difficulty arises from the practice of including the faculties of graduate and

Table 3. Ph.D. productivity of institutions with different types of religious affiliation.

Type of affiliation	No. of institutions	Adjusted productivity index			
		Natural sciences		Arts, humanities, and social sciences	
		Mean	S.D.	Mean	S.D.
Catholic	81	209	32.9	189	26.5
Protestant	157	198	29.0	163	28.5
Difference		11		26	
Probability		$< .02$		$< .01$	

Table 4. Ph.D. productivity and college characteristics.

Characteristic*	No. of institutions	Correlation with adjusted productivity index	
		Natural sciences	Arts, humanities, and social sciences
Type of student body (coed.)	511	.21†	.26†
Number of volumes in library	488	.29†	.11†
Size of 1956 freshman class	511	.22†	−.04
Size of city	510	−.06	−.18†
Student/faculty ratio	498	.05	.12†
Level of training offered (Ph.D.)	511	.13†	−.04
Religious affiliation	511	−.12†	.04
Type of control (public)	511	.11†	−.03
Cost	511	−.04	.05

* The number of institutions varies because of incomplete data in the sources used for classification. Characteristics in parentheses indicate qualities weighted positively in computing point-biserial correlations. Signs of residuals have been reflected so that positive correlations indicate the characteristics associated with greater productivity. † $P < .01$.

professional schools in the denominators of such ratios. A clearer picture of the environments favorable to AHSS achievement is revealed by an analysis of faculty behavior associated with productivity.

Faculty Behavior and Productivity

To identify faculty behavior which motivates students to seek the Ph.D., student reports of faculties at 36 institutions varying in productivity were compared. The 36 colleges and universities were all institutions with relatively large enrollments of winners or near-winners in the National Merit Scholarship competition. Some 916 Merit finalists—all sophomores at the time of the study—were used as informants. The number of student observers per college averaged 25 and ranged from 12 to 47. Since the distributions of productivity measures for the 36 institutions had much smaller variances than the productivity distributions for the total group of 511 colleges and universities, the observed correlations are probably underestimated.

Each student observer completed an inventory consisting of 300 true-false items (*11*). Only those items which can be interpreted as measures of faculty behavior will be discussed here.

Items which seem to describe the same trait and which exhibit the same pattern of correlations with the two productivity measures have been grouped together. The hypothesized traits represented by each cluster, together with typical items, are listed in Tables 5 and 6. In Table 5 the 12 institutions which ranked highest in NS productivity among the 36 selected for study are compared with the 12 institutions ranking lowest. A similar analysis of faculty behaviors related to AHSS productivity is presented in Table 6.

Table 5. Faculty behavior and Ph.D. productivity in the natural sciences.

Hypothesized trait*	Items most descriptive of cluster	Percentage of observers† giving keyed response		Percentage difference
		Twelve most productive institutions	Twelve least productive institutions	
Informality and warmth of student-faculty contacts (+)	In talking with students, faculty members often refer to their colleagues by their first names. (F)	66	78	−12
	Faculty advisers and counselors are pretty practical and efficient in the way they dispatch their business. (T)	64	71	− 7
Emphasis upon high academic standards (+)	Personality, pull, and bluff get students through many courses. (F)	84	66	18
	The professors really push the students' capacities to the limit. (T)	60	45	15
Emphasis upon high standards of faculty selection and productivity (+)	Course offerings in the natural sciences are outstanding. (T)	87	75	12
	The school is outstanding for the emphasis and support it gives to pure scholarship and basic research. (T)	84	77	7
Closeness of supervision (−)	In many classes students have an assigned seat. (T)	35	62	−27
	Student organizations are closely supervised to guard against mistakes. (T)	18	30	−12
Directiveness of teaching methods (−)	It is hard to prepare for examinations because students seldom know what will be expected of them. (F)	60	88	−28
	It is easy to take clear notes in most courses. (T)	75	84	− 9

* Plus and minus signs indicate whether the trait is positively or negatively related to productivity.
† There were 334 observers at the most productive institutions and 328 observers at the least productive institutions.

The faculties of schools high in natural science productivity are described as follows. First, their contacts with students are characterized by informality and warmth: open displays of emotion are not likely to embarrass them; in talking with students they frequently refer to colleagues by their first names; they are not as likely to be described as practical and efficient in dealing with students; students do not feel obliged to address them as *professor* or *doctor*. Second, they emphasize high academic standards: according to student reports their standards are exacting; they see through the pretenses and bluffs of students; they push students to the limits of their capacities; and they give examinations which are genuine measures of the student's achievement and understanding. Third, they have high standards for evaluating faculty productivity and selecting new faculty members: the faculty values pure scholarship and basic research, and the course offerings and faculty in the natural sciences are outstanding. Fourth, the faculty does not play the role of Big Brother: students need not sit in assigned seats and attendance is not taken; student organizations are not closely supervised to guard against mistakes; faculty members are tolerant and understanding in dealing with violations of rules. Finally, they tend to be more nondirective in teaching methods: students find it relatively hard to predict examination questions and to take clear notes in class; instructors less frequently outline explicit goals and purposes for courses; students are not required to submit outlines before writing term papers and reports.

Motivation to seek the Ph.D. in arts, humanities, and social sciences appears to be influenced by a different set of faculty traits. There are to be sure, some items which are correlated with both measures of productivity—particularly those which relate to emphasis upon preparing for graduate study and freedom from close supervision—but the differences are more striking than the similarities (*12*). The following traits seem to characterize faculties outstandingly successful in encouraging undergraduate

students to get the Ph.D. in the arts, humanities and social sciences: (i) excellent social science faculty and resources, (ii) a high degree of energy and controversy in instruction, (iii) broad intellectual emphasis, (iv) frequent contacts with students outside the classroom, (v) a flexible, or somewhat unstructured, curriculum, (vi) emphasis upon independent study and the development of a critical attitude, (vii) excellent offerings in the arts and drama, and (viii) relatively infrequent appraisals of student performance.

Discussion

The identification of faculty behavior conducive to the development of intellectual talent is especially important since it may suggest methods for improving higher education. The results reported in this paper indicate that the teacher plays an important role in motivating talented undergraduates to seek advanced degrees. Equally important, the characteristics of undergraduate instruction which encourage the potential natural scientist seem to differ from those which stimulate the student in the arts, humanities, and social sciences. With improved techniques for assessing the overt behavior of college faculties, it should be possible to clarify the different roles the effective teacher must play.

This study needs to be supplemented in a number of respects. First, the practice of using different observers to report on different colleges may affect the results. It is possible that the college's students represent a biased sample and that systematic errors of observation are operating. If so, descriptions of faculty behaviors may be distorted by the peculiarities of student informants. Ultimately, it may be necessary to send a team of observers to each institution. An alternative would be to use faculty observers to report on teaching methods at different institutions. A comparison of the reports of faculty members with those of students should reveal whether observational biases are operating.

Second, the foregoing analysis rests upon the assumptions that student bodies have been adequately equated with respect to ability and initial motivation to enter graduate study, and that talent supplies and environments of colleges remain relatively the same over a period of years. Obviously, students at women's colleges have not been adequately equated with those at male or coeducational institutions with respect to motivation to enter graduate study; the low standing of women's colleges is therefore to be expected. Longitudinal studies which follow talented students (matched for aptitude and initial motivation) through undergraduate and graduate years would provide more rigorous tests

Table 6. Faculty behavior and Ph.D. productivity in the arts, humanities, and social sciences.

Hypothesized trait*	Items most descriptive of cluster	Percentage of observers† giving keyed response		Percentage difference
		Twelve most productive institutions	Twelve least productive institutions	
Excellence of social science faculty and resources (+)	Course offerings in the social sciences are outstanding. (T)	79	29	50
	The library is exceptionally well equipped with journals, periodicals, and books in the social sciences. (T)	96	61	35
Energy and controversy of instruction (+)	Professors often try to provoke arguments in class, the livelier the better. (T)	53	34	19
	Faculty members put a lot of energy and enthusiasm into their teaching. (T)	87	72	15
Broad intellectual emphasis (+)	Many courses stress the speculative or abstract rather than the concrete and tangible. (F)	12	44	−32
	There is a lot of emphasis on preparing for graduate work (T)	81	52	29
Frequency of student-faculty contacts outside the classroom (+)	Students almost never see the professors except in class. (F)	71	52	19
	Faculty members are impatient with students who interrupt their work. (T)	14	23	− 9
Flexibility of curriculum (+)	If a student fails a course he can usually substitute another one for it rather than take it over. (F)	30	88	−58
	Students are expected to work out the details of their own program in their own way. (F)	28	48	−20
Emphasis upon independent study (+)	Most courses require a lot of library work. (T)	65	15	50
	In class discussions, papers, and exams the main emphasis is on breadth of understanding, perspective and critical judgment. (T)	95	80	15
Excellence of college offerings in art and drama (+)	The school offers many opportunities for students to understand and criticize important works in art, music, and drama. (T)	90	43	47
Frequency of appraisals of student performance (−)	Frequent tests are given in most courses. (T)	26	64	−38

* Plus and minus signs indicate whether the trait is positively or negatively related to productivity.
† There were 334 observers at the most productive institutions and 268 observers at the least productive institutions.

of the generality of these findings. Such studies are now being initiated with finalists in the National Merit Scholarship Program.

Summary

A method for comparing the effectiveness of undergraduate colleges in stimulating their students to seek the Ph.D. is described. The procedure yields separate measures of productivity in the natural sciences and in the arts, humanities, and social sciences, adjusted to control differences in college talent supplies. The results suggest that the productivity measures have substantial validity, and argue for the importance of faculty behaviors in stimulating or inhibiting intellectual achievement.

References and Notes

1. This research was partially supported by the National Science Foundation and the Old Dominion Foundation. I am also indebted to John L. Holland and Laura Kent for their editorial assistance, and to Lindsey Harmon for making available unpublished data on doctorate production in American universities.

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3. R. H. Knapp and H. B. Goodrich, *Origins of American Scientists* (Univ. of Chicago Press, Chicago, 1952). These authors report an analysis for a small sample of 50 colleges in which productivity rates are adjusted for diversities in student quality. Geographic differences and cost of attendance were the only variables which appeared to be significantly related to the adjusted indices (p. 342). However, the major analysis ignores differences in supplies of college talent.
4. R. H. Knapp and J. J. Greenbaum, *The Younger American Scholar: His Collegiate Origins* (Univ. of Chicago Press, Chicago, 1953).
5. A. E. Traxler, "An appraisal of American colleges on the basis of men graduates listed in *Who's Who in America*" (paper presented at the meeting of the AAAS, Indianapolis, 29 Dec. 1957).
6. The college's first-time, opening enrollment was used as an index of the freshman class: M. C. Johnson and A. J. Fenton, *Opening Enrollment in Higher Educational Institutions, Fall, 1956* and *Fall, 1957*, U.S. Department of Health, Education, and Welfare, Circulars 496 and 518 (Washington, D.C., 1957–58).
7. The product moment correlation between the 1956 and 1957 talent supply indices of 511 colleges is .92. Further, the correlation between mean ACE scores of entering freshmen at 19 Minnesota institutions of higher learning, over the 7-year period 1947–1954, was .80 (data from W. R. Layton, University of Minnesota, personal communication).
8. *The Baccalaureate Origins of Science Doctorates Awarded in the United States, 1936–1950*, Office of Scientific Personnel, National Academy of Sciences–National Research Council, Publ. No. 382 (Washington, D.C., 1955); *Baccalaureate Origins of Doctorates in the Arts, Humanities, and Social Sciences Awarded in the United States, 1936–1950*, Office of Scientific Personnel, National Academy of Sciences–National Research Council, Publ. No. 460 (Washington, D.C., 1956); *Doctorate Production in United States Universities, 1936–1956*, Office of Scientific Personnel, National Academy of Sciences–National Research Council, Publ. No. 585 (Washington, D.C., 1958). The classification of disciplines described in the last-mentioned publication was used in the present study to obtain separate indices, for productivity in the natural sciences and in the arts, humanities, and social sciences; thus anthropology, geography, and psychology are included within the social sciences.
9. *Earned Degrees Conferred by Higher Educational Institutions, 1947–48*, Office of Education, Circ. No. 247 (Washington, D.C., 1949); *Earned Degrees Conferred by Higher Educational Institutions, 1948–49*, Office of Education, Circ. No. 262 (Washington, D.C., 1950).
10. The regression analyses were actually performed on logarithmic transformations of the percentages, since both the rates of producing Ph.D.'s (in the natural sciences and in the arts, humanities, and social sciences) and the rates of enrolling Merit finalists were highly skewed.
11. C. R. Pace and G. C. Stern, *College Characteristics Index, Form 457* (The authors, Syracuse, N.Y., 1957).
12. This is not surprising since the correlations between the two productivity measures are only .09 for the 36 selected institutions and .35 for the entire group of 511 colleges and universities.

Deposition of Strontium-90 through October 1958

The global deposition of strontium-90 is discussed in relation to the absorption of the isotope by man.

Merril Eisenbud

This article is intended to update previous reports (*1*, *2*) in which the present and future global deposition of strontium-90 were discussed in relation to the contamination of foods and deposition of this isotope in the skeleton of man.

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Methods of Measurement

The accumulation of fallout in various parts of the world continues to be documented by the methods described earlier. The oldest method is that of the network of gummed films, which was initiated in 1952 and which permits daily observations of the rate and accumulation of fallout at a great many locations in the United States and abroad. In addition, beginning in 1955, soil samples have been collected annually from a number of locations and have been analyzed radiochemically for strontium-90 (*3*). A third method is the collection of deposited or precipitated dust in pots. Such sampling was begun by the United States in early 1954, and the program now includes 41 stations in the United States and elsewhere (*4*).

Although it is the most difficult of the three methods, radiochemical analysis of soil is the best indicator of the possible human hazard in that it is a direct measure of the strontium-90 potentially available for introduction into biological processes. However, for some purposes it is desirable to know not only how much strontium-90 has accumulated in the soil at any given time but what the fallout rate is over a given period of time. The use of pots or gummed film is convenient for determining both.

A serious limitation to the use of gummed films is the fact that the amount of strontium-90 is not determined directly but is computed from a measurement of total beta activity. This computation requires access to classified

but uniformity theory wks.

information concerning the dates and size of nuclear detonations (*5*). Until June 1957, estimates of cumulative strontium-90 fallout based on gummed-film data were in approximate agreement with estimates obtained from direct radiochemical analyses of samples collected in pots. Figure 1, which has been developed from published data (*5, 6*), illustrates the comparative data for that time.

Previous articles (*5, 7*) have called attention to the increasing difficulty of estimating the strontium-90 content of the radioactivity collected by the gummed films. During late 1957 and for the first 10 months of 1958, the tempo of testing was such that the mixtures of tropospheric and stratospheric debris of various ages and in uncertain ratios greatly increased the difficulty of calculating the strontium-90 component from the estimated age of the total beta activity. For this reason, the estimates of strontium-90 from gummed-film measurements have not been continued beyond June 1957. The loss of this source of information has been offset by the fact that the network of monthly pot collections has been expanded greatly since 1957. In addition, an excellent set of soil samples has been collected by the Department of Agriculture at 76 localities in 36 countries.

Pattern of Fallout

The data of the gummed-film network for the years 1955 through 1957 are plotted together with the results of the 1958 soil analyses in Fig. 2. The gummed-film data for the United States and the islands of the trust territories of the western Pacific Ocean were excluded from this figure because the deposition pattern in these areas is affected primarily by local meteorological factors and the location of the testing grounds. For example, the winds in the western part of the United States are such that the strontium-90 deposition at San Francisco, to the northwest of the Nevada proving grounds, was 11 millicuries per square mile in mid-1957 compared with 54 millicuries per square mile at Salt Lake City, located at a comparable distance to the northeast. This difference, which is due entirely to the pattern of the prevailing winds, would mask the less pronounced variations which are attributable to other factors at greater distances from the sites of detonation.

The data for all soil samples collected by the Department of Agriculture (*8*) are included, but the results from four samples collected in Oahu have been averaged and included as a single value so as to not unduly weigh the average value for the band at 20° to 30° north latitude.

The fallout pattern has varied systematically with latitude during the three years since 1956, but the relatively high North Temperate Zone values were not evident in 1955. The latitudinal variation for the latter three years proves to be in agreement with the work of Stewart *et al.* (*9*) in the United Kingdom and tends to support the suggestion first made by Stewart and his colleagues that the global pattern of strontium-90 deposition is influenced by the manner in which stratospheric-tropospheric exchange takes place. Citing the model of the exchange mechanism advanced by Brewer (*10*), Stewart noted that radioactive debris injected into the stratosphere should deposit preferentially in the North Temperate Zone.

It has been noted by others that the North Temperate Zone of maximum deposition coincides with the latitudes in which much of the testing has occurred and that the relatively high deposition values may therefore result from the fallout of tropospheric debris. A strong argument against this possibility is that the 1958 cumulative deposition in the band at 30° to 70° north latitude is about 1.5 megacuries. If all of the tropospheric debris of United States and Soviet origin were deposited in this band, this would account for a maximum of only 25 percent of the observed amount. In view of the fact that some of the debris was known to be deposited outside the 30° to 70° band, one can conclude that stratospheric debris accounts for more than 75 percent of the observed deposition. This is consistent with the estimate of 80 percent I made in 1956 (*2*).

The areas under the deposition curves may be integrated to yield approximations of the global fallout of strontium-90. The values thus obtained are 0.59, 1.1, 1.9, and 2.3 megacuries, respectively, for each of the four years of ob-

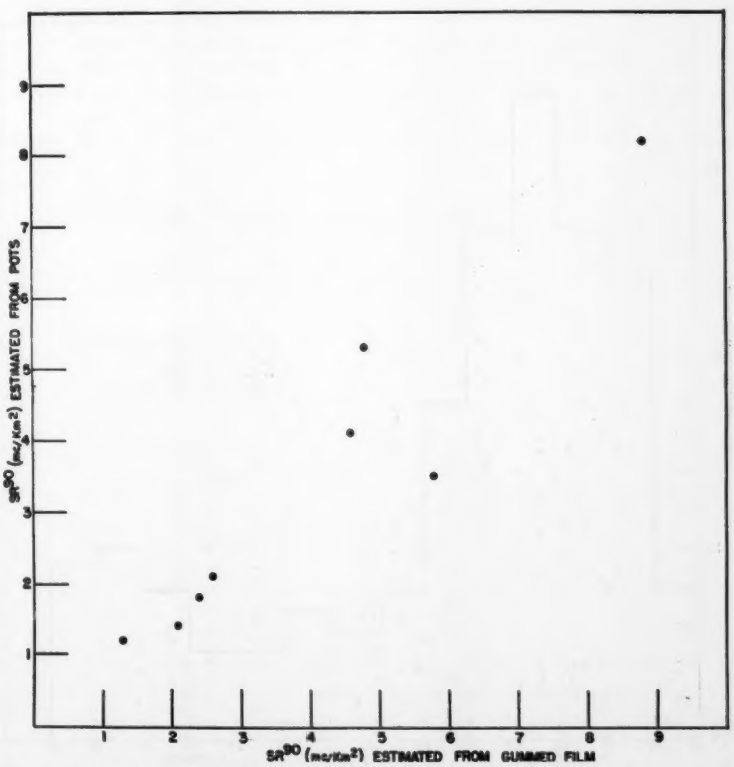

Fig. 1. Comparison of cumulative deposition of strontium-90 at various places as estimated from pot and gummed film samples.

servations. The estimates for 1955 and 1956 have been revised from earlier estimates of 1.0 and 1.5 megacuries (*1*, *2*).

The cumulative estimates through 1957 are calculated from measurements of total beta activity (*5*). However, a correction previously used (*7*) on the basis of earlier comparisons of soil analysis with gummed-film estimates has been eliminated in view of the more recent comparative data (*5*).

There has been increased emphasis on stratospheric sampling for strontium-90 both in the United States and abroad. However, data from these studies are as yet preliminary, and one must continue to depend on estimates derived from material balance studies. The starting point in this calculation utilizes classified data of the yields of the individual detonations and estimates of the fraction of the debris that is deposited initially in the vicinity of the detonation. The total amount of strontium-90 distributed in the atmosphere can then be apportioned between the troposphere and stratosphere. This apportionment depends on the energy released in the detonation, the height of burst, and meteorological factors.

Table 1. Concentration of strontium-90 in cow's milk during the last three months of 1958.

Place	Laboratory*	Type of milk	Date sampling was begun	Concentration (μμc/g of Ca)
New York, N.Y.	HASL	Liquid	June 1954	9.8
New York, N.Y.	USPHS	Liquid	May 1957	8.7
Perry, N.Y.	HASL	Dry	April 1954	8.2
Mandan, N.D.	HASL	Dry	April 1955	20
Sacramento, Calif.	USPHS	Liquid	April 1957	4.2
Salt Lake City, Utah	USPHS	Liquid	April 1957	4.8
St. Louis, Mo.	USPHS	Liquid	April 1957	16
Cincinnati, Ohio	USPHS	Liquid	March 1957	10
Atlanta, Ga.	USPHS	Liquid	June 1958	8.8
Austin, Tex.	USPHS	Liquid	June 1958	3.8
Chicago, Ill.	USPHS	Liquid	July 1958	7.4

* HASL, U.S. Atomic Energy Commission, Health and Safety Laboratory, New York; USPHS, U.S. Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

I originally estimated the stratospheric inventory in September 1955 to be 3.0 megacuries (*1*). It now appears that a value of 2.0 megacuries would have been more reasonable. The inventory was estimated to be 1.8 megacuries in June 1956 (*2*) and again in June 1957, indicating that the stratospheric burden remained essentially unchanged during that period. As Libby has previously noted (*11*), the debris injected into the stratosphere apparently compensated for the deposition that took place during those years.

Although global data on the soil content of strontium-90 do not exist beyond the period of collections in early 1958, it is of interest to extrapolate the observed depositions to 1 November 1958, when the suspension of weapons tests took effect. One observes that the increase in global deposition between June 1957 and April 1958 was 0.4 megacuries, or 0.04 megacuries per month. Assuming that this rate continued until the end of October 1958, one may estimate the global deposition to have been 2.6 megacuries of strontium-90 at that time.

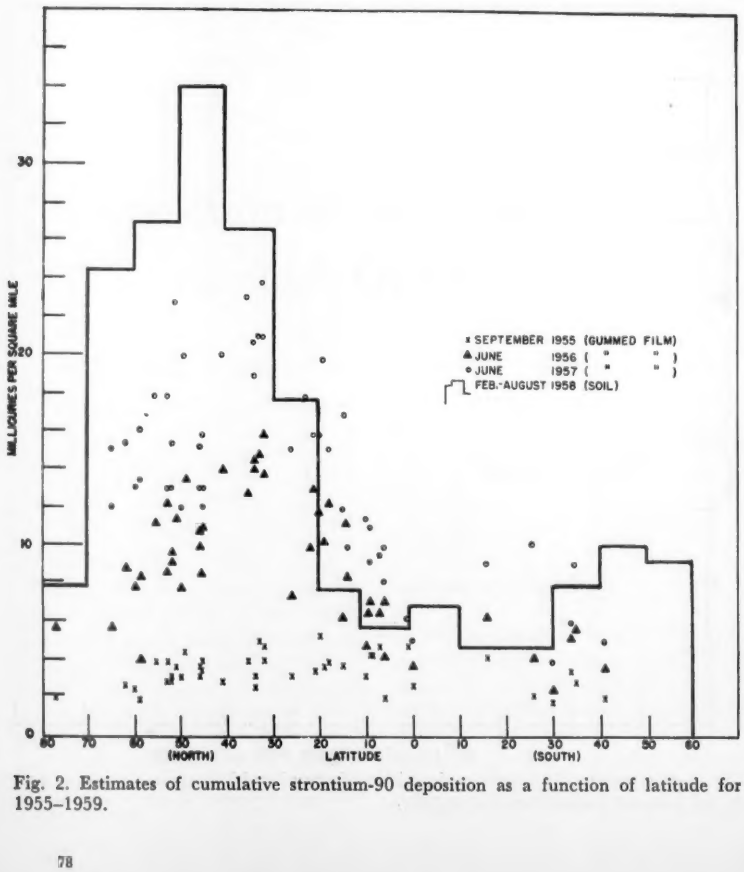

Fig. 2. Estimates of cumulative strontium-90 deposition as a function of latitude for 1955–1959.

Future Deposition

In order to estimate the maximum future deposition from strontium-90, it is assumed that the debris now stored in the stratosphere will be deposited on the earth in approximately the same pattern as that observed in the spring of 1958. It is estimated that 6.4 megacuries of strontium-90 were injected into the stratosphere by all detonations up to 31 October 1958. Of the 2.6 megacuries deposited globally, 20 percent is assumed to be of tropospheric origin. We have thus accounted for 2.1 of the original 6.4 megacuries leaving an estimated stratospheric reservoir of 4.3 megacuries.

The ultimate global deposition may thus be estimated to be the 6.4 megacuries originally injected to the stratosphere plus 0.5 megacuries of tropo-

spheric origin. This totals 6.9 megacuries from which one must subtract the 25 percent which will have decayed in the next 10 years, by which time over 90 percent of the debris will have been deposited. This is based on the estimate that approximately 50 percent of the stratospheric debris is eliminated every 3 years (*12*). Thus, the deposit on earth will reach approximately 5 megacuries, roughly twice the levels observed in 1958.

Absorption by Man

In the United States and other western countries at least half of the calcium deposited in the skeletons of human beings through adolescence originates from dairy products. Milk has therefore been used as one basis (*1*) for estimating the concentration of strontium-90 which may be expected in human skeletons that reach equilibrium with an environment contaminated with strontium-90.

The Atomic Energy Commission and the U.S. Public Health Service have been analyzing milk from a number of areas in this country and abroad for various periods of time since 1954 (*3, 13*). The concentration of strontium-90 during the last quarter of 1958 is given in Table 1, which also indicates when sampling at each location first began. It is shown that in recent months the concentration of strontium-90 in milk has varied from 4.2 to 20 micromicrocuries per gram of calcium at the locations sampled.

Estimates of the future exposure of human beings to strontium-90 may be based on the assumption that over a period of several months the average concentration of strontium-90 in milk is directly proportional to the strontium-90 in the soil in which the cow's forage is grown. Estimates made in this way are apt to be in error on the high side, because one thus ignores absorption due to foliar deposition of strontium-90. Moreover, this assumption implies that the isotope, once deposited in soil, remains fixed in the root zone of the forage from which cows derive their nourishment.

For New York state, for which data are available for the years since 1954, a coarse proportionality between the concentration of strontium-90 in soil and in milk is demonstrated in Fig. 3. The soil values are derived from radiochemical analyses of soils collected annually at Rochester and Binghamton, New York.

Table 2. Summary of estimates of strontium-90 contamination.

Time of estimate	Cumulative global fallout (Mc)	Stratosphere reservoir (Mc)	Sr^{90} content of New York milk* (μμc/g of Ca)	Expected global deposit in 10 yr assuming 90% deposition of stratospheric debris (Mc)	Maximum expected Sr^{90} content (μμc/g of Ca)		
					New York milk, from tests prior to time of estimate	Human skeleton in equilibrium with New York milk	Reference
Sept. 1955	0.6	1.9	1.9	1.7	5.5	2.8	*1*
June 1956	1.1	1.8	3.3	2.0	6.0	3.0	*2*
June 1957	1.9	1.8	3.9	2.6	5.3	2.7	This report
Oct. 1958	2.6	4.3	5.9	4.9	11.0	5.5	This report

* Mean of monthly values for calendar year.

Should the trend shown in Fig. 3 continue, the strontium-90 content of milk can be expected to increase when the strontium-90 now stored in the stratosphere is deposited on the earth. From the previous estimate of the stratospheric inventory in late 1958, it follows that if the geographic pattern of future deposition is similar to the pattern of the past, the strontium-90 concentration in both the soil and milk of New York may be expected to double in the years to come.

The milk from New York state contained an average of 5.9 micromicrocuries of strontium-90 per gram of calcium during 1958. It can be anticipated that the level of strontium-90 in the milk in this area may eventually rise to 11 micromicrocuries per gram of calcium from tests conducted up to November 1958. Values of about three times this level would define the upper limit for other areas in the United States.

As was noted previously, the proportionality discussed above will not apply if strontium-90 is leached from the root zone over a period of years. That such leaching does occur is suggested by soil analyses which have shown that during

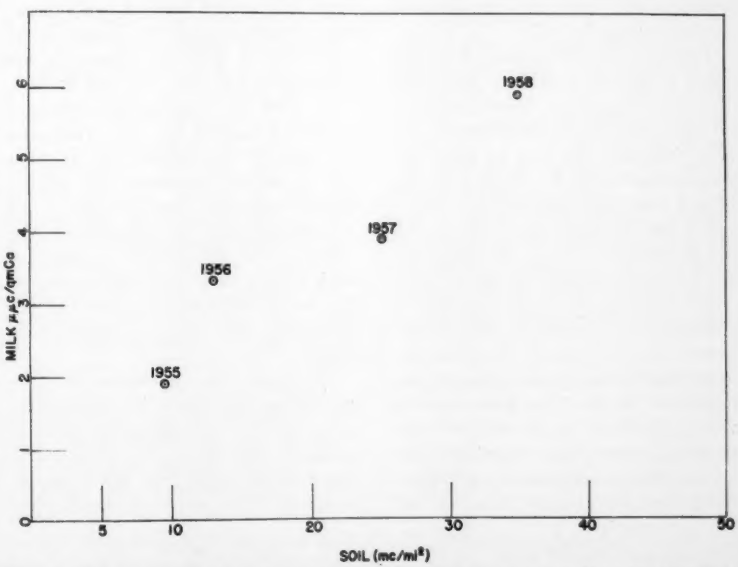

Fig. 3. Mean concentration of strontium-90 in milk from western New York plotted against the mean soil content of stontium-90 at Rochester and Binghamton.

the past three years increasing proportions of strontium-90 have been found in the lower levels (*3*). Estimates of future contamination of foods based on the assumption that strontium-90 is retained in the upper few inches of soil may, over a period of decades, yield estimates which will possibly err on the side of safety.

If, however, we assume that the strontium-90 will remain fixed in the root zones of forage, the only mechanism for diminishing the strontium-90 content of milk will be radioactive decay. Children who are born at the point of maximum soil deposition and who derive their calcium from dairy products, will, for all practical purposes, form a skeleton which is in equilibrium with the strontium-90 contamination of the environment from which their food is derived. Comar (*14*) has shown that skeletons formed from milk diets contain about 0.5 times the strontium-calcium ratio of the original milk. With this discrimination against strontium, human skeletons formed from dairy products in the northeastern United States could reach a maximum strontium-90 concentration of 5.5 micromicrocuries per gram of calcium.

Actual measurements of strontium-90 in human bone have been undertaken by Kulp (*15*) during the past several years. In 1957–58 bones of children in the 1- to 2-year age group contain 1.8 micromicrocuries of strontium-90 per gram of calcium. Kulp's work demonstrated that the values observed in human beings are consistent with the levels of strontium-90 currently found in food.

This is the fourth consecutive year in which it has been possible to make estimates of the maximum foreseeable skeletal contamination for dairy diets in the New York area. The data for these four years are summarized in Table 2. It may be seen from these data that the forecast values have increased markedly during the past year, due in a large measure to the heavy test schedule of the U.S.S.R.

The estimates of future strontium-90 contamination of milk and bone are believed to be conservative estimates of the upper limits of maximum sustained contamination in the New York area. In view of the fact that this mode of computation ignores foliar deposition, and because there is no provision for possible removal of strontium-90 from the soil by natural means other than decay, it is expected that the observed values will in fact be lower than those forecast. On the other hand, during, and for some months following, actual testing, excursions above the forecast levels may be expected in view of the fact that some measure of foliar deposition of strontium-90 is known to occur during such periods.

The United Nations Scientific Committee on the Effects of Atomic Radiation calculated (*16*) that 1 micromicrocurie of strontium-90 per gram of calcium is equivalent to a dose of 1 millirems per year to the bone marrow. An individual having 5.5 micromicrocuries of strontium-90 per gram of calcium in his skeleton will therefore receive a dose of 5.5 millirems per year in addition to the dose from natural radiation of cosmic and terrestrial origin. According to the United Nations Scientific Committee, skeletal irradiation from natural sources is 125 millirems per year. The 5.5 micromicrocuries of strontium-90 per gram of calcium will therefore increase the natural dose to the bone marrow by about 5 percent.

Summary

It is estimated that the global deposition of strontium-90 increased from 1.9 to 2.6 megacuries during the period from June 1957 to October 1958. During this time the stratospheric reservoir of strontium-90 increased from 1.4 to 4.3 megacuries. Approximately 90 percent of the deposition of debris now stored in the stratosphere will have occurred by 1970.

In 1958, the strontium-90 content of powdered milk in the New York area averaged 5.9 micromicrocuries per gram of calcium in comparison with 3.9 micromicrocuries per gram of calcium for the previous year. For this region of the country, the strontium-90 content of milk appears to be increasing in proportion to the strontium-90 content of the soils from which the cows derive their forage.

The upper limit of foreseeable contamination in milk can be estimated by assuming that this proportionality will continue until all of the strontium-90 has been deposited from the upper atmosphere. This procedure should yield estimates which tend to err on the side of safety. In this manner, it is estimated that the maximum foreseeable sustained level of milk contamination in the New York area is 11 micromicrocuries per gram of calcium. A child deriving its calcium from dairy sources may be expected to develop a skeleton having 5.5 micromicrocuries per gram of calcium. This estimate is double that made in June 1957 and reflects the increased stratospheric inventory due to U.S.S.R. detonations in 1958.

The radiological dose to the skeleton from natural sources such as cosmic rays, radium, potassium, and so forth, is approximately 125 millirems per year. A skeletal burden of 5.5 micromicrocuries of strontium-90 per gram of calcium will deliver a dose of approximately 5.5 millirems per year to the bone marrow. The maximum foreseeable dose from strontium-90 in the New York area is thereby estimated to be about 5 percent of the dose due to natural radioactivity.

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Effectiveness of an Oral Contraceptive

Effects of a progestin-estrogen combination upon fertility, menstrual phenomena, and health.

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In previous papers we described the effectiveness of certain 19-nor steroids, when orally administered, as inhibitors of ovulation in animals (*1*) and man (*2*). Subsequent studies demonstrated that the combination of a small amount of estrogen with these progestins permitted the regular, repeated induction of artificial menstrual cycles in women taking the medication from the 5th to the 25th day of the cycle (*3, 4*). This property of maintaining normal menstrual cyclicity along with repression of ovulation led to the experimental testing of a norethynodrel-estrogen combination as an oral contraceptive, and reports of the first 18 months of a study made in San Juan, Puerto Rico, have been made (*4, 5*). After our initial experience in San Juan, two projects were initiated in Humacao, Puerto Rico, and one in Port-au-Prince, Haiti. We have recently collected and analyzed the data (to November 1958) from these four projects (*6*) and present here the outstanding findings derived from these data; 830 subjects took the medication for a total of 8133 menstrual cycles, or 635 woman-years.

The same regimen of tablet-taking was followed in all projects—namely, one tablet a day (10 mg of norethynodrel plus 0.15 mg of ethinyl estradiol 3-methyl ether) from the fifth through the 24th day of the menstrual cycle. Regular visits were made to each subject, and a record was kept of the length of each cycle, the nature of the menstrual flow, the occurrence of "side reactions," the frequency of coitus, the number of days of tablet-taking that were missed, and any other noteworthy phenomena. In addition, physical examinations of representative samples of each group were made from time to time, and in October 1958, data were obtained for over one-third of the women in each project from pelvic examinations, two liver-function tests (thymol turbidity and cephalin flocculation), endometrial biopsies, and vaginal smears.

Sixteen certain and one probable pregnancy occurred in women taking the medication; this represented a rate of 2.7 pregnancies per 100 woman-years and a 96-percent reduction in the premedication rate of 61.2 pregnancies per 100 woman-years. In Table 1 we present the distribution of these pregnancies according to the number of days of tablet-taking that were missed in the cycle in which conception occurred. It is clear that if the regimen is followed faithfully, practically 100-percent contraception occurs; it is also clear that the rate of conception is proportional to the number of tablets missed. Analysis of the data indicates no habituation to the medication—that is, pregnancies occurred at about the same rate in long-term users as in short-term users.

Among the menstrual-cycle phenomena recorded we observe the following: (i) a mean cycle length of 28.6 days with a normal frequency distribution; (ii) the occurrence of flow during the course of medication (breakthrough bleeding) in 2 percent of the cycles; (iii) a temporary amenorrhea in 0.8 percent of the cycles, with regular withdrawal bleeding in 99.2 percent; (iv) a reported increase of menstrual flow in 6 percent of the cycles, no change in 46 percent, and a decrease in 48 percent; (v) no significant change during medication cycles in the reported incidence of pain associated with menstruation.

Side Reactions

"Side reactions," such as nausea, headache, dizziness, vomiting, gastralgia, and malaise, were reported in 10.9 percent of the 4988 cycles in San Juan, in 6.3 percent of the 1410 cycles in the first Humacao project, in 18.3 percent of the 658 cycles of the second Humacao project, and in 7.3 percent of the 1077 cycles of the Port-au-Prince project. In each instance the largest percentage of these reactions was reported in the first cycle of medication and declined to low levels thereafter. The similarity of reactions to those common in early pregnancy and their subsequent subsidence is noteworthy. Similarly, the frequency of breakthrough bleeding was highest in the first medication cycle.

These data suggest an accommodation to the medication, probably involving uterine response to the level of the stimulation established by the drug. However, interesting results were found in a double-blind study of placebo versus true medication effect in which women continuing to use conventional contraceptives were given either a placebo or the true drug. In 41 cycles of 15 women taking the placebo, breakthrough bleeding occurred in 4.9 percent, suggesting that medication was not responsible, and reactions were reported in 17.1 percent of the cycles, suggesting a psychogenic factor; in 30 cycles of 13 women given the true medication, a higher incidence of breakthrough bleeding (16.7 percent) and of reported reactions (23.3

Table 1. Pregnancies according to number of tablets missed.

No. of tablets missed	No. pregnant	Rate per 100 woman-years
0	1 ?	0.2
1– 5	5	7.7
6–19	11	43.3

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percent) occurred, but these values are not significantly higher on a statistical basis. Furthermore, in 48 cycles of 15 women (separated by a great distance from the others) who were given the medication with no admonition as to possible reactions or menstrual irregularity, the frequency of breakthrough bleeding was 2.1 percent and that of reactions, 6.3 percent.

On being questioned at the October examinations, approximately 55 percent of the subjects reported weight increases occurring during medication, 25 percent reported no change, and 20 percent reported weight decreases. Similar questioning concerning general health disclosed that 39 percent felt an increase, 10 percent a decrease, and the balance no change, in well-being. Concerning libido, 20 percent reported an increase, 22 percent a decrease, and the balance no change. However, the data on frequency of coitus disclose that increasing frequency was reported by approximately 50 percent, decreasing frequency by 40 percent, and no change by 10 percent.

The data on over 200 pelvic examinations disclose: (i) a restoration of involuted *postpartum uteri* to normal size but not to hypertrophy even after 30 or more cycles of medication; (ii) an inconsistent change in the degree of cervical erosion; (iii) no pathological changes in the adnexae or vagina. No pathological breast changes were seen, and all vaginal smears were negative by Papanicolaou stain. Among the 148 liver-function tests, one was positive with respect to liver-tissue damage, a frequency consistent with the occurrence of this condition in the general population of these areas.

Table 2. Data for individuals who withdrew from the San Juan project.

No. of cycles prior to withdrawal	No. of individuals	Other contraceptives not used regularly*			Other contraceptives used regularly†		
		No.	Percent pregnant	Exposure (months)	No.	Percent pregnant	Exposure (months)
1– 5	55	30	87	6.2	25	16	55
6–10	16	10	80	5.0	6	17	39
11–15	7	6	67	11.0	1	0	
16–20	8	8	88	4.2			
Totals	86	54	83	6.1	32	15	52

* The mean conception rate is 193 per 100 exposure years. † The mean conception rate is 27 per 100 exposure years.

Table 3. Effects of lowering dosages on menstrual-cycle phenomena.

Dose per day (mg)	No. of cycles	Mean length (days)	Subjects		
			With reactions (%)	With breakthrough (%)	With amenorrhea (%)
2.5	46	26.2 ± 0.51	8.7 ± 4.1	15.2 ± 5.3	2.2 ± 2.2
5.0	224	27.3 ± 0.20	12.5 ± 2.2	2.7 ± 1.1	2.2 ± 1.1
10.0	4718	27.9	10.9	2.0	2.2

Table 4. Reasons for withdrawal.

Reason	San Juan		Humacao-R		Humacao-P		Haiti	
	No.	%	No.	%	No.	%	No.	%
Reactions	64	28.2	5	41.8	10	32.3	3	7.3
Not interested	36	15.9	1	8.3	0	0.0	17	41.5
Pregnant	12	5.3	1 ?	8.3	1	3.2	3	7.3
Unrelated illness	16	7.0	0	0.0	0	0.0	2	4.9
Husband opposed	5	2.2	0	0.0	0	0.0	1	2.4
Moved	34	15.0	3	25.0	6	19.3	9	22.0
Sterilized ♂ or ♀	29	12.8	1	8.3	6	19.3	0	0.0
Separated	20	8.8	0	0.0	6	19.3	2	4.9
Miscellaneous	11	4.8	1	8.3	2	6.5	4	9.7
Total withdrawing	227		12		31		41	
Total No. of subjects	438		117		126		149	
Percent withdrawing	51.8		10.3		24.6		27.5	

Efficacy

In San Juan 86 women who withdrew from the project after 1 to 20 cycles of medication were observed further, and the occurrences of pregnancy were noted. The data, presented in Table 2, indicate no impairment of fertility in those not regularly using other means of contraception, and no tendency toward impairment in long-term as compared with short-term users. The mean conception rate of 193 per 100 woman-years of exposure is not significantly different from the premedication rate of 244 per 100 woman-years for the San Juan subjects prior to medication. The oral contraceptive would appear to be ten times as effective as the other contraceptives used.

For certain subjects who had been taking the standard dose of the drug, the dosage was halved in 224 cycles and quartered in 46. Relevant data presented in Table 3 indicate no significant difference between the efficacy of norethynodrel at the 10- and 5-mg levels, but indicate a tendency toward shorter cycles and an accompanying increased frequency of premature bleeding at the 2.5-mg level. Since we have previously shown (*3*) that adequate endometrial sustainment requires a level of the ethinyl estradiol methyl ether at least double that (0.037 mg) present in the quartered dose, the possibility of controlling breakthrough bleeding by means of higher estrogen dosage is being tested. It should be noted that no conceptions occurred at these lower dosage levels.

Acceptability

The acceptability of this method of contraception may be examined by listing the reasons given for withdrawal from each project. These are presented in Table 4. In three projects, 28.2 to

41.8 percent of those withdrawing did so because of reactions; in the fourth project, lack of interest was the prime cause of withdrawal. Between them, these two reasons account for 32 to 50 percent of the withdrawals. Since the reactions are in large measure psychogenic, means for dealing with them may be devised. We have, in fact, shown that an antacid, or even a placebo, pill will relieve up to 90 percent of these reactions (*4, 5*). The lack of interest is due chiefly to lack of motivation among an economically low-level group. The actual rate of withdrawal was highest for the first year of operation of the San Juan project, in which 50 percent of the subjects who started had withdrawn by the end of the year. In contrast, in the Humacao-R project, 11 percent of those who started had withdrawn by the end of the year. We believe these high withdrawal rates for the San Juan project to be due to the following factors: (i) the availability of sterilization for contraception as well as the availability of other means economically practical; (ii) frequency of moving, chiefly to the continental United States; (iii) improvement in economic situation, which makes larger families less undesirable; and (iv) difficulties attendant upon initiating and testing this new method of contraception. Actually, among those starting the second year of medication, the withdrawal rate fell to 30 percent, and in Humacao-R, to less than 1 percent. In the latter project is a stable group of very poor women who are highly motivated, and in this project, begun a year after the one in San Juan, the supervisor had full knowledge of the difficulties encountered during the first year in San Juan. It is perhaps significant that in Haiti, where the population is also quite poor but where it is less stable, the first year's rate of withdrawal for all causes was 34 percent.

Questions and Answers

For the period studied, the foregoing data appear to us to answer the following questions, in the manner indicated: (i) Is the method contraceptively effective? yes; (ii) does it cause any significant abnormalities of the menstrual cycle? no; (iii) does it adversely affect the reproductive tract and adnexae? no; (iv) does it have physiologically adverse effects generally? no; (v) does it affect the sex life of the subjects adversely? no; (vi) does it impair fertility upon cessation? no; (vii) may a low dosage level of the drug be used? yes; (viii) is the method acceptable? yes, but to an extent which varies with motivation, economic situation, and other factors (*7*).

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J. P. Greenstein, Biochemist and Investigator of Cancer

The sudden death of Jesse Philip Greenstein on 12 February 1959 ended a career of outstanding achievement. Dr. Greenstein had achieved eminence in his extensive work on the chemistry of amino acids, peptides, and proteins, and on the biochemistry of cancer.

He was born in New York City on 20 June 1902 and did his undergraduate work at the Polytechnic Institute of Brooklyn, from which he was graduated in 1926 with honors in chemistry. He then went to Brown University, where he worked with C. A. Kraus and P. H. Mitchell. His Ph.D. thesis dealt with electrometric determinations of the dissociation of glycine and certain simple peptides; its character foreshadowed much of his later work. In 1930–31 he was a National Research Council fellow at Harvard, under Edwin J. Cohn, where he continued and extended his studies on the ionization constants of peptides. This was followed by a year's work in Dresden under Max Bergmann, who was just developing the carbobenzoxy method of peptide synthesis. Greenstein's experience in Bergmann's laboratory profoundly influenced his subsequent career. With Bergmann and Zervas he was the first to apply the new methods to the synthesis of lysylglutamic acid and lysylhistidine, and he developed a mastery of both organic and physical chemistry, particularly in relation to the study of peptides and proteins, which was exceptional among the biochemists of his generation.

After a year in Berkeley in the laboratory of C. L. A. Schmidt, he returned to Harvard for six years (1933–39). During this period he was active as a tutor in biochemical sciences at the college and was also research associate at Harvard Medical School, in Cohn's laboratory. His zeal and enthusiasm for both teaching and research, and his extraordinary energy and enthusiasm, were strikingly displayed then as later. As tutor in biochemical sciences he looked after a larger number of students than any other member of the board has ever been responsible for, and served as an inspiring and effective teacher in frequent personal conferences with students. He also served as head assistant to L. J. Henderson in the latter's course in biological chemistry; indeed, as Henderson's major interests were shifting from biochemistry toward sociology, Greenstein for several years was largely responsible for the general management of the course. At the same time he was astonishingly productive in research. He continued to synthesize new peptides and to study their ionization constants and correlate these with their structure, and, in collaboration with J. Wyman and T. L. McMeekin and others, he studied

their dipole moments, solubility, and other physical properties. During these years he began those important studies of the peptides of cystine and cysteine to which he returned, with results of outstanding importance, nearly twenty years later.

Soon he turned also to the study of protein structure and denaturation, making use of porphyrindin, which had recently been synthesized by Richard Kuhn, for the determination of protein sulfhydryl groups, in native and denatured proteins. He discovered the powerful action of guanidinium salts as denaturing agents for proteins and made extensive use of them and of concentrated urea solution.

In 1939 his career entered a new phase when he became a member of the National Cancer Institute at Bethesda. Here again his extraordinary energy and vitality displayed themselves. He threw himself into an extremely active program for the study of the biochemistry of tumors, and in particular set about the determination of the activities of a variety of enzymes—arginase, amylase, catalase, xanthine dehydrogenase, and many others—in normal and cancerous tissue. This long series of studies, which extended over many years and involved numerous collaborators, represents probably the most extensive work of its kind yet carried out on cancer tissue. From this he evolved the concept of the "biochemical uniformity of tumors," the near-uniformity of tumors being due to the loss in a normal tissue, when it becomes malignant, of those specific functional characteristics which distinguish it from other normal tissues. The tumors which so emerge bear little or no physiological resemblance to their normal tissues of origin and appear to converge to a common type of tissue. Thus, normal hepatic and gastric tissues are very distinctly different, but biochemically the hepatoma and the gastric adenocarcinoma are closely similar. These researches were summarized, together with a comprehensive and critical survey of the whole field, in Greenstein's outstanding monograph *Biochemistry of Cancer,* first published in 1947 and extensively revised in a second edition which appeared in 1954.

During his first years in Bethesda he also devoted himself vigorously to the study of nucleoproteins, in normal and cancer tissue, at a time when the importance of these substances was less widely recognized than it is now. His interest in the study of protein denaturation remained unabated, and with Neurath, Putnam, and Erickson he published a review of this subject in 1944 which has become one of the classics in the field.

Jesse Philip Greenstein

In 1946 he was appointed chief of the newly created Laboratory of Biochemistry of the National Cancer Institute, a position which imposed upon him an increasing burden of administrative responsibility. His breadth of vision, his enthusiasm, and his patient good humor and understanding of many diverse types of people were of great importance in the development of the research activities of the institute and in attracting workers to it from all over the United States and from the rest of the world.

These heavy adminstrative responsibilities, however, did not prevent him from continuing with an extraordinarily active program of research; indeed, the last dozen years of his career were probably the most productive of all. He made intensive studies of dehydropeptides and dehydropeptidases, of many cellular peptides, of the enzymatic desulfuration of cystine peptides, of the deamidation of glutamine and asparagine, and of other problems too numerous to mention here.

His outstanding contribution to the chemistry of the amino acids, and thereby to biochemistry and nutrition, lay perhaps in his superb researches on the preparation of optically pure L- and D-amino acids, in which he utilized the asymmetric hydrolytic or oxidative specificity of the amino acid acylases and oxidases to prepare the optical enantiomorphs in better than 99.9-percent purity. These researches have made pure L- and D-amino acids readily available—a matter of great importance for studies of nutrition, for synthesis of pure polypeptides, and for other kinds of biochemical work.

Greenstein also achieved purification of a series of amino acids with two asymmetric centers—threonine, isoleucine, and others. The possible isomers of these amino acids were cleanly separated and characterized, and to a large extent their absolute stereochemical configuration was unraveled.

In the last years of his life he initiated an extensive series of nutritional researches with diets containing mixtures of optically pure amino acids. His work also demonstrated the toxic effect of injecting amino acid mixtures lacking in arginine, and the protective effect of the addition of arginine to these mixtures, which was clearly shown to be due to the function of arginine in the Krebs urea cycle, whereby the toxic ammonia released from other amino acids was rapidly converted to urea.

During these final years he also carried out an important series of further researches on the peptides of cystine. At the time of his death he was engaged, with M. Winitz, in the writing of a comprehensive treatise in three volumes on the chemistry of the amino acids. Fortunately they had completed nearly all of this great work except for the final section of the third volume, which is now being finished by Winitz.

Greenstein was awarded the Neuberg medal in 1950, the Distinguished Service award of the Department of Health, Education, and Welfare in 1952, and the Hillebrand award in 1958. In 1954 he served as chairman of the Division of Biological Chemistry of the American Chemical Society. He was for several years an editor of the *Archives of Biochemistry and Biophysics,* and, with A. Haddow, was editor of *Advances in Cancer Research.* He served as visiting professor of biochemistry at the University of California in 1948, and in 1957 he became a member of the Committee on Biochemistry of the National Research Council and served as the chairman of the Subcommittee on Amino Acids. In 1949 he was a member of the American delegation of the Cancer Colloquium called by Pope Pius XII at the Vatican, and in 1956 he was a visiting lecturer at several Japanese universities and became an honorary member of the

Japanese Chemical Society and the Japanese Foundation for Cancer Research.

He led an arduous life as an investigator, administrator, and writer. During his career he published about 300 scientific papers in addition to the books referred to above. In all of these enterprises he took a constant and active part in every piece of research that was published under his name and was personally responsible for writing all of the papers to which his name was attached. His hours of work were long. After dinner at home he would, several times each week, return to the laboratory quite early in the evening, where he could write or experiment uninterruptedly until one or two o'clock in the morning. Yet with all of this activity he was accessible, friendly, and relaxed when anyone came to see him and talk things over with him. During the last three years of his life he had become a boating enthusiast; starting originally with a small outboard motor, he had purchased in 1958 a 22-foot cabin cruiser and had received several certificates from the Washington Area Power Squadron.

His interests were broad and ranged far beyond the sciences. He was always a prolific reader. In his Harvard days I can remember well his delight in Dickens, and especially in *Pickwick Papers*. He read widely in philosophy, theology, and biography and was something of an expert on the history of the Civil War —its battles, issues, and great men. Undoubtedly the breadth of his reading and his appreciation of literature had much to do with the high quality of his own writings.

Jesse Greenstein was outstanding in scientific skill, learning, energy, and devotion to his work. He inspired numerous young men, who came to work at the National Cancer Institute, with much of his own ardent enthusiasm for science. He was proud to be a servant of the United States Government, in a position of great responsibility, and his service went far beyond the allotted duties of his post. He was a loyal friend, whose wisdom and courage were a source of inspiration to his colleagues. His death leaves a gap that will be difficult to fill.

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News of Science

Views on Secrecy Given by American Nobel Prize Winners

Responding to a letter from Senator Thomas C. Hennings (D-Mo.), chairman of the Senate Constitutional Rights Subcommittee, 17 American Nobel Prize winners from various fields of science have given their views on the effect of security restrictions on the progress of science in the United States. Most of the scientists stated that their work was such that they had had little contact with classified information. With only one exception, however, they agreed that free exchange of information was the lifeblood of scientific progress and that restrictions of this flow were usually either foolish or destructive. A number of the scientists cited the experiences of colleagues to support their views on the security problem. Selman Waksman cited the case of a researcher who did not receive proper credit for his work because other researchers, free of security restrictions, had published before he was allowed to do so. One scientist, Walter H. Brattain, who was a prize winner in 1956, ended his letter with this admonition: "Don't kill the baby just to protect it from the kidnappers." Excerpts from some of the letters follow.

Dickinson W. Richards: "In a broad sense, however, every scientist suffers when there is any restriction, at any level, to the free exchange of knowledge. Except in so far as such restrictions are absolutely required by the exigencies of national defense, we believe that there should be no restrictions. We should like, for example, to have scientists from Russia and from China visit us freely and without hindrance, we should like to discuss with them problems of mutual interest, teach them and learn from them, we should like to have their young men come and live and work with us, and if there should be a sufficient opportunity for our young men to learn, to have them go and work there."

John Bardeen: "Rapid exchange of information has been vital to this progress. What is done in one laboratory today may depend on results obtained in another laboratory in a different part of the world only months before. For example, one of most exciting developments of the past three years was made by a physicist working in an industrial laboratory in Japan. His idea was soon taken up and is now being pursued by several laboratories in this country.

"With its very advanced technology, the United States is able to take best advantage of any new development in the field. The most important thing is to spare no effort so that our country remains in front and does not lag behind. We then have nothing to fear and everything to gain from free exchange of scientific information."

Walter H. Brattain: "Even more fundamental to this matter is the whole philosophy of our political system. It seems to me that it is based primarily on the premise that if our citizens are well informed they will, under our system, take the appropriate political action and come to the right decision. However, we now find ourselves in a very peculiar situation. Because of security restrictions that seemed quite justified in the atomic area, our nation is faced with very momentous decisions and since our citizens do not have access to the essential information, the basis on which our political system operates is undermined. All our citizens can do is to trust that those of our elected officials who do have access to this information will make the right decision. Does anybody want to argue that our founding fathers had any idea that the system they proposed would operate

properly very long under such conditions as these?"

Felix Bloch: "To quote a specific example in which I have first hand experience, I want to mention the circumstances under which I made the discovery of nuclear induction. My previous work had been in the field of atomic and nuclear physics and it was only my occupation with radar problems during the war which made me familiar with the, then, highly restricted information of radio techniques. The discovery consisted in the application of these techniques to some properties of atomic nuclei and could not have been made without the knowledge of both. It occurred to me only because I worked fortuitously in the one of the many small and separated compartments of war research which happened to contain the information which I needed."

Glenn T. Seaborg: "I think that if there is any conclusion upon which all scientists have complete agreement it is that exchange of information is vital for maximum progress and elimination of waste motion. Also, since, among human pursuits, science is almost unique in being immediately transferable across national boundaries, exchange of information must be considered on a global basis. As chairman of a committee of the United States Senate, you are properly concerned with the implications of free international exchange of information on our position as a nation. Contrary to what one might guess, it is the nation in which science is already flourishing that stands to gain greatly. The probability that a new idea or development in methods can be exploited in generating new ideas and developments is proportional to the number of receptive ears which hear about it and to the adequacy of facilities for doing something about it."

Edward C. Kendall: "The objective of all creative research is to enlarge the horizon which circumscribes the fund of knowledge in the world of science. The best situation in the best of possible worlds would be rapid dissemination of all new work. The information thus made available would, of itself, be a powerful stimulus. This would lead to a constantly increasing acceleration and would indeed be the tangible evidence of what Prof. Charles Beard has cited as the 'invention of invention.'

"As a dismal contrast one merely has to go to the other possible extreme. In such a world, investigators in all research laboratories and medical institutions would work behind locked doors. No results would be published, all workers would be isolated, all publicity by the association of science writers would be suppressed. Interest in science would decrease, the tempo and scale of research would slow down, a feeling of indifference and hopelessness would crush initiative, a moratorium on progress would ensue."

Percy W. Bridgman: "The scientist feels so strongly about this [freedom of communication] that I believe it may well be a decisive factor deterring a young man about to choose his career from entering a [field] subject to such restrictions. A manifestation of this same feeling is the decision of Harvard University, and of other universities also, not to engage in any work with government money under government contract which was not freely publishable. I myself have not had close connection with government work, but in one instance I was decisively influenced by considerations of this sort. At the close of the war I declined to continue work under government contract on a subject of some real scientific interest to me because I found association with the government, and in particular the probability of secrecy restrictions, too distasteful."

William P. Murphy: "It is my impression that the effect of restrictions on the free exchange of information on science developments is at least somewhat exaggerated and that it is actually rather minimal. Much of the complaint has come from a few physicists who are perhaps influenced by a more radical group who are more vocal in their objections because of their basic beliefs.

"It is my belief that restrictions should be continued and perhaps increased in those branches of science which are concerned with the sensitive areas of scientific development where restriction may be more important than would be the benefits which might be derived from the free dissemination of information."

Bill to Spur Private Philanthropy Introduced in Senate

A Congressional move to stimulate private philanthropy for education has been strengthened by the introduction in the Senate of a companion bill to one introduced earlier this year in the House of Representatives. The Senate bill, S 2241, was entered 24 June by James Murray (D-Mont.). The earlier bill, HR 2440, was introduced 15 January by Representative Frank Thompson (D-N.J.). The two bills, which are identical, are designed to equalize the out-of-pocket costs, to individuals as well as corporations, of gifts to institutions of higher learning. Under the present laws it costs a wealthy man considerably less to give away a dollar than it does a man of moderate means. When a person with a taxable income of over $400,000 a year gives a dollar to philanthropy, 9 cents comes from his pocket and 91 cents from the tax that he would otherwise have had to pay. When a person with a taxable income of $5000 gives away a dollar, 80 cents comes from his pocket and 20 cents from his tax payment.

At this writing the Ways and Means Committee, to which Thompson's bill was referred, is waiting for reports on the measure from the departments of the Treasury and Health, Education, and Welfare. After these reports have been considered the committee will decide whether to send the bill to the House floor.

Murray's companion bill has been referred to the Senate's Finance Committee, chaired by Harry Byrd (D-Va.). There, as in the House, reports will be requested from the pertinent departments of the government, in this case probably the Budget Bureau and the Treasury. Beyond this, the Senate will probably do little more until the House acts, since the House alone has authority to initiate taxation and revenue-raising bills. Murray's action, however, is important because it gives the bill greater publicity and allows the Senate to become familiar with the provisions of Thompson's proposal. Also, with both chambers considering the measure, earlier action is possible.

$53 Million Asked for 2-Year Seismic Research Program

The Panel on Seismic Improvement, a subgroup of the President's Science Advisory Committee, recently submitted a detailed report on the need for fundamental research in seismology. The report consists of the panel's recommendations for a research program that would resolve many of the present uncertainties over detection and concealment of underground nuclear blasts. The panel points out that the program, which might be directed by the National Academy of Sciences, would greatly advance seismology. Excerpts from the report follow.

The problems of detection and identification of underground nuclear explosions have focused attention on the need for increased support of seismological research. At present (neglecting private research in petroleum exploration geophysics, most of which does not apply to the present problem), the annual budget in the United States from all sources for seismological research amounts to roughly several hundred thousand dollars. This supports investigations at a modest level of the earth's internal constitution and limited analytical studies on seismic wave propagation. Research at this level and less over the last half century has been sufficient to delineate the major elements of the earth's internal constitution and to explain many features of seismograms. . . . However, seismologists have long recognized that major advances in their field could be realized only if the level of research were significantly increased. . . .

[In this report we treat] conditions at the source, effects of transmission through the earth, instrumentation for recording seismic signals, and certain suggestions for more sophisticated processing of the recorded data. . . .

Our present state of knowledge in this field [of source phenomena] results from a variety of approaches, all of which have been explored to only a minor degree. The radiation pattern from the source has been studied for, at most, a few hundred earthquakes, the majority of which were large shocks recorded throughout the world. . . . Further studies, based on large shocks and on a world-wide network with improved instrumentation, should be conducted to improve our understanding of the fundamental tectonic processes in the earth. It is equally important to conduct studies of the radiation pattern on a smaller scale in seismic localities. Semi-permanent installations should be concentrated in a region of known seismicity, operated until sufficient data on shocks in the region are obtained, then moved to a new locality. Data collected in such a manner would provide information, not only on the radiation pattern of the source, but also on the depth of focus and on aftershock sequences. . . . .

Our knowledge of seismic wave generation by large explosions, particularly nuclear explosions, is very limited. Only three completely contained underground explosions with yields greater than one kiloton have been fired, all under very similar environmental conditions. . . .

The following experimental nuclear shots should be carried out as soon as feasible: (a) a 5 KT [kiloton] shot in granite for information on the effect of shooting in another medium, (b) a shot in an environment situation designed to decouple explosion-energy from seismic energy, (c) two 5 KT shots near the Rainier site but at appreciably greater depths. Theoretical studies which suggest the possibility of concealment by reduced coupling should also be experimentally tested as soon as feasible. . . .

Propagation To Be Studied

An earthquake relieves strain over a volume measured in cubic kilometers and behaves like an extended source. An explosion is essentially a point source. This essential difference may show up in differences in the spectra of seismic waves radiated from earthquakes and explosions. Similar effects may also result from the difference in the shallow depth of the explosions as compared with the greater depth of most earthquakes. Further investigations should be conducted for proper understanding and exploitation of such effects. . . .

A program of crustal exploration based on explosion seismology, and including supplemental studies such as gravity traverses, etc., should be begun which draws on the skills, instrumentation and manpower of commercial geophysical exploration and which takes advantage of the experience and judgment of geophysicists specializing in the broader aspects of crustal structure. Such a program is certain to produce information on such basic questions as the modification of seismic waves by earth structure, the origin and manner of growth of continents, the mechanism of orogeny and isostatic compensation, and the composition of the crust and upper mantle. . . .

The basic data of seimology are recordings of earthquakes and explosions as gathered by first class seismograph stations. Advances in research would accompany an increase in the number of such stations in the world and the most effective way to accomplish this is to upgrade existing stations. It is recommended that 100–200 of the existing stations in the world be equipped with modern instruments as soon as possible, without obligating the grantee beyond agreeing that the station would be maintained and operated at his expense. Existing traditions in seimology provide for access to records by qualified investigators. It seems desirable as a step in improving the U.S. seismic capability to first equip existing American stations with the best instruments now available, and to establish new stations. . . . It should be made clear that this action should in no way justify a decrease in the number of stations in a monitoring network. . . .

Special Detectors Needed

A specific program for the development of improved general purpose seismographs is recommended. It may be noted that sufficient information now exists to commence with certain parts of this work particularly those parts which deal with the incorporation of advanced engineering concepts into the design of new equipment. Other parts of the work can be most profitably undertaken only after new information has been accumulated on properties of noise and signals.

Certain special purpose detectors are also recommended. The development of unattended telemetering seismic detectors would permit the establishment of a network of auxiliary stations around selected primary stations. These proposed auxiliary units would be capable of receiving, storing and transmitting seismic data, either continuously, on an internally programmed basis, or upon demand by the primary station. They should be sealed, tamper-proof devices, capable of operating for 30 to 60 days without servicing. . . .

A second special purpose instrument is the "throw-away" or portable seismic detector. Such detectors, designed for rapid deployment in as many environmental situations as possible, could be used both for research purposes and by inspection groups for investigating unidentified events. They could provide comprehensive information on first-motion patterns as well as on the areal extent of occurrence and on the size of aftershocks. The instruments must be capable of continuous operation and transmission of data in analog form to a central recording station over periods of several days. . . .

The Panel places great emphasis on the immediate need to construct a complete experimental station incorporating all features of the seismic stations recommended by the Geneva Conference of Experts. Operating this station for a period of time would serve the two immediate objectives of providing experimental evidence on the capability of such stations to detect and identify earthquakes, and of assisting in working out installation and operational problems which would be encountered in establishing a control network. Subse-

quently the station should be expanded to include facilities for testing other detection methods proposed by this Panel or methods which may be developed through future research programs. A high priority should be given to testing arrays of up to 100 seismometers and testing a system of unmanned auxiliary stations. . . .

Finally, research should be stimulated to develop new methods of detection. The Panel suggests two specific approaches. One method is based on a line of theoretical reasoning, supported by some experimental data, which suggests that seismographs installed and operated at depths of several thousand feet below the earth's surface may have the capability to detect smaller P-waves than those detectable at the surface. This approach is suggested by considerations which show that the surface noises, which now limit detection, may die off more rapidly with depth than do the signals of interest from explosions and earthquakes. A second approach, based on a somewhat similar line of reasoning, suggests that there may be extremely low noise levels at the bottoms of the oceans, at least at some frequencies. The development of a reliable operational detection system, based on either of these approaches, involves the solution of some major engineering problems; the expected signal-to-noise improvements, however, are potentially so great that the experiments necessary to test the basic theories should be conducted as soon as possible. Work is in progress at the present time on the first method, and some preliminary equipment design work has been completed on the ocean-bottom seismometer. . . .

Data Processing Must Be Centralized

The Panel recommends the establishment of a central computer facility, available to all seismologists, where the computations necessary to the research outlined in this report can be made. Allowance should be made for supplementary computing facilities which will also be required by individual research projects. A library of digitalized seismograms, to include earthquakes, explosions and noise samples should be maintained at the computing center. . . .

Since there are many thousands of events recorded per year at some seismic stations, to perform this analysis adequately by manual methods will require a large skilled staff. The use of computers should be investigated as a means of performing at an adequate rate the tasks of filtering and decision making that are required of the Geneva system. . . .

New Panel Recommended

It is recommended that an advisory panel be established, perhaps through the National Academy of Sciences, to perform these functions. The Panel has demonstrated how effectively a group drawn from research seismologists, physicists, mathematicians and enginers can function in advancing seismological research and it is recommended that the advisory panel be similarly constituted.

It is strongly recommended that this program be viewed as a "package," one centrally funded and directed, in order to derive the fullest benefits. . . .

The Panel believes that the research program can best be carried out by various existing private, university and government laboratories, coordinated by a panel of scientists, possibly under the aegis of the National Academy of Sciences. In contrast to this arrangement for research, the Panel recommends that the "system development" responsibility be assigned to a *single* well organized central laboratory. Such a laboratory should have competence not only in seismology, but also in development, engineering, and large system operation. The laboratory would [probably] sub-contract with private industry for much, or perhaps all, of the specific hardware develment and procurement. However, it is essential that the laboratory have full responsibility for the planning of the system (including its orderly metamorphosis with time), for field trials, for implementation, and possibly for the American portion of its operation. . . .

The Panel . . . recognizes that this program will result in dramatic advances in our knowledge of the earth's interior, of the mechanism of earthquakes, and of elastic wave propagation. Now that seismographic stations are being planned for placement on other planets, seismological research will bear on new questions relating to the origin of the solar system. . . .

It is the opinion of the Panel that [such] research studies will certainly improve detection capabilities of underground nuclear detonations. However, the improvements are not likely to be evaluated adequately . . . in a detection system before one year of research activity at best. Most of them will undoubtedly require more time, perhaps three years. Thus, it is important to conceive of the detection system as one which will gradually evolve with time and reach a high level of detection capability only after several years.

(In a table accompanying the report, the panel gave an estimate of approximately $53 million as the cost of its basic 2-year research program in seismology. This figure includes the costs of individual research projects, system development, and nuclear and high-explosive detonations but excludes the cost of implementing a detection system. The panel suggested that the program should continue after the conclusions of the basic program at least at the level of expenditure of the first two years.)

Deadline for Euratom Proposals Extended

The U.S. Atomic Energy Commission and the Commission of the European Atomic Energy Community have extended from 1 September to 20 October 1959 the deadline for definitive proposals for nuclear power projects under the U.S.-Euratom Joint Program. The date was extended at the request of President Etienne Hirsch of the Euratom Commission. The extension will give interested utilities within the Community additional time to evaluate fully the bids of prospective reactor manufacturers, to make necessary arrangements with their respective governments, and to prepare their final proposals for submission to the Joint Reactor Board. Letters of intention to participate in the program have been received from five such utilities, but several of these groups requested a short extension of the deadline in order to complete the preparation of their proposals.

Controversy in New Jersey

A small, private research laboratory, set up in farm buildings in the residential section of Morristown, New Jersey, has embroiled its owner, George Mangun, in a controversy that may have to be resolved in the higher courts of the state. Two questions are at issue: Does Mangun's small medical research laboratory violate the zoning laws of Mendham Township? And, if so, are the laws, which allow physicians, surgeons, and engineers to maintain offices in the area, being unduly applied against Mangun's activities? The Township Committee has given an answer, an affirmative one, to the first question. It has given Mangun

20 days to end his studies which are concerned with pain-killing drugs. Mangun, however, maintains that his work is not a business, in the sense intended by the zoning laws, and, on this basis, plans to appeal the committee's decision.

Telescope-Balloon Flights

A 12-inch solar telescope, equipped with a closed-circuit television link, will make a series of flights by balloon this summer. The television camera will be linked to a motion picture camera to obtain a continuous record of images that appear in the telescope reflector. Director of the project is Martin Schwarzschild of Princeton University, who directed similar balloon flights in 1957.

The purpose of sending the telescope up in a balloon is to get it above the earth's atmosphere, which obscures celestial objects. To get high-resolution photographs of the sky it is necessary to send telescopes above the tropopause, a turbulent layer at about 40,000 feet. The turbulence causes fluctuations in refraction of light from the sky. Under the best atmospheric conditions the 20-inch telescope at Mount Palomar can rarely distinguish between two points on the moon's surface less than 1800 feet apart, while it could distinguish between points only 120 feet apart if it did not have to "look" through the earth's atmosphere.

The 1957 flights, made under the sponsorship of the Office of Naval Research and with assistance from the Air Force Cambridge Research Center, resulted in the first successful attempts at high-altitude observations. The special sun telescope-camera, which with considerable modification will be used this summer, made two unmanned balloon flights and took photographs of the sun's surface that were unprecedented in clarity and detail. The photographs showed for the first time the detailed polygonal structure of the convective currents ("granulations") that bring much of the internal solar energy to the sun's surface.

Senate Adds $363 Million to Funds for Health Agency

The Senate, on 24 June, added $363 million to the amount requested by President Eisenhower to operate the Department of Health, Education, and Welfare and the Department of Labor. The bill, which appropriates more than $4 billion for the two agencies, was approved by a vote of 83 to 10. It must now be reconciled with a bill passed by the House of Representatives, which calls for somewhat lower amounts. This is the first time this session that the Congress has gone above the President's budget figures in an appropriations bill.

The major increase was that of $186 million in medical research funds, making $480 million for this item. The breakdown of appropriations recommended by the Senate for the eight divisions of the National Institutes of Health for the fiscal year that begins 1 July is as follows (House figures in parentheses).

Cancer, $110.2 million ($83.3 million); Mental Health, $79.9 million ($60.4 million); Heart, $89.5 million ($52.7 million); Dental Health, $10.1 million ($9.7 million); Arthritis and Metabolic Diseases, $51.2 million ($37.8 million); Allergy and Infectious Diseases, $41 million ($30.3 million); Neurology and Blindness, $48.9 million ($33.6 million); and General Research and Services, $49.6 million ($36.4 million).

Canadian Radar Laboratory

The Prince Albert Radar Laboratory, the Canadian Defence Research Board's new atmospheric research facility at Prince Albert, Saskatchewan, was officially opened on 6 June by Prime Minister Diefenbaker, in the presence of prominent Canadian and United States scientists and senior representatives of the armed forces of both countries. Sponsored jointly by the DRB and the United States Air Force, this new research facility will be employed for investigations of the various factors involved in radar detection of aircraft and missiles entering the auroral zone.

The most conspicuous object at the 700-acre site will be the 84-foot radar "dish" loaned to Canada by the U.S. Air Force. It will be mounted on a massive concrete base, and its top will be 125 feet from the ground. The complete installation is under construction on a high point about 7 miles west of Prince Albert. The Canadian installation is a "twin" of the U.S. Air Force's giant research radar installed at Millstone Hill near Boston by the Lincoln Laboratory. The Prince Albert installation and its U.S. counterpart will be among the largest research facilities of their kind in the Western world.

Scientists in the News

KARL SAX is retiring as professor of botany at Harvard University. A geneticist and experimental horticulturist, he pioneered in the study of the structure and behavior of chromosomes and the effects of radiation upon them. He received his M.S. and Sc.D. degrees from Harvard University and his Ph.D. from Stanford University. For 8 years he worked at the Maine Agricultural Experimental Station before joining the faculty of Harvard in 1928, where he became professor of botany in 1935. He was formerly director of the Arnold Arboretum and supervisor of the Bussey Institution and is currently president of the Genetics Society of America. Following his retirement, Sax will join the Yale University faculty for a year as visiting professor of botany; the following year he will join the botany department at Oxford University on a Guggenheim fellowship.

VICTOR K. LA MER, professor of chemistry at Columbia University, recently left for Australia to spend 6 months with the Division of Physical Chemistry of the Commonwealth Scientific and Industrial Research Organization, Chemical Research Laboratories, Fishermen's Bend, Victoria.

EDWARD W. HAYES, SR., associate professor of thoracic diseases at the College of Medical Evangelists, Loma Linda and Los Angeles, Calif., has received an alumni achievement award from the alumni association of Carleton College.

SHERWOOD GITHENS, director of the Internal Research Division of the Office of Ordnance Research, U.S. Army, Durham, N.C., has been named deputy chief scientist of the Office of Ordnance Research.

ARNIE J. SUOMELA, commissioner of the U.S. Fish and Wildlife Service, has been named chairman of the International Commission for Northwest Atlantic Fisheries. He succeeds K. SUNNANA of Norway.

The Hektoen Gold Medal of the American Medical Association has been awarded to a team of surgeons from Tulane School of Medicine for the best scientific exhibit at the 108th annual meeting of the association in Atlantic City, N.J. Members of the team include:

OSCAR CREECH, JR., professor of surgery and chairman of the department; EDWARD T. KREMENTZ, associate professor of surgery; KEITH REEMTSMA, assistant professor of surgery; ROBERT F. RYAN, assistant professor of surgery; JAMES WINBLAD, instructor in surgery.

LESTER J. EVANS, executive associate of the Commonwealth Fund, has been appointed director of New York University's Center for Rehabilitation Services, effective 1 November.

BURTON W. ADKINSON, head of the Office of Science Information Service, National Science Foundation, has been appointed the 1959–60 president of Special Libraries Association, New York.

ROBERT E. SNODGRASS, retired entomologist of the U.S. Department of Agriculture and honorary collaborator of the Smithsonian Institution, has been presented with the first copy of *Studies in Invertebrate Morphology,* a book published by the Smithsonian Institution in his honor on the occasion of his 84th birthday.

DEREK J. DE SOLLA PRICE, British physicist and historian, will be visiting professor of the history of science at Yale University for the academic year 1959–60.

HANS VON LEDEN, assistant professor of otolaryngology, Northwestern University Medical School, and Paul Moore, lecturer in the same department, have won two international awards for their film *The Larynx and Voice—Laryngeal Physiology Under Daily Stress.* The first of these—the Gold Medal of the Italian Red Cross—was awarded at the fourth International Review of Scientific Films, held in Rome. The second was awarded at the third International Review for Scientific Education, held at the University of Padua.

JOSEPH D. RYAN, director of research, has been named general director of research and development at Libbey–Owens–Ford Glass Company, Toledo, Ohio. He succeeds H. M. ALEXANDER, who recently became vice president.

ROY W. WAMPLER, associate director of research, has been appointed director of research.

WILLIAM N. LIPSCOMB, JR., chief of the division of physical chemistry at the University of Minnesota, has been appointed professor of chemistry at Harvard University.

WILLIAM C. SHAW, formerly a physicist with the Institute for Atomic Research, has been named professor of physics at the Southern Illinois University Residence Center.

ALEX KOTCH, formerly research chemist with E. I. du Pont de Nemours and Company, Wilmington, Del., has joined the National Science Foundation as a professional assistant in the chemistry program.

HARLEY H. BARTLETT, professor emeritus of botany of the University of Michigan and former director of the Botanical Gardens at the university, has been named president of the Institute for Regional Exploration, Ann Arbor, Mich. He succeeds GEORGE M. SUTTON, who has been president since 1955.

MAX KROOK, astrophysicist in the Smithsonian Astrophysical Observatory, Cambridge, Mass., has been appointed professor of applied mathematics and astrophysics at Harvard University.

RICHARD H. BARNES, dean of Cornell University's Graduate School of Nutrition, has been appointed editor of the *Journal of Nutrition.* He succeeds GEORGE R. COWGILL of Yale University Nutrition Laboratory, who has been editor for 20 years. The editorial offices of the journal have been moved from New Haven to Ithaca.

MELVIN MARK, professor of textile engineering at Lowell Technological Institute, Lowell, Mass., has been appointed dean of faculty at the institute.

MARION B. SULZBERGER, professor and chairman of the department of dermatology and syphilology at New York University–Bellevue Medical Center, has been elected president of the American Dermatological Association.

HARVEY C. LEHMAN, professor emeritus of psychology at Ohio University, has received a Distinguished Professor Award from the university. The award was established this year by the university's board of trustees.

Recent Deaths

FREDERICK A. MITCHELL-HEDGES, Shaldon, England; 76; explorer, who in 1952 discovered traces of what may have been East Africa's earliest civilization; discovered the ruins of the Vat Mayan city of Lubaantun in British Honduras, in 1924, and a race of primitive people in an unknown area in the interior of Panama in 1922–23; 12 June.

KATHARINE R. JEFFERS, Medford, Mass.; 52; dean of Jackson College and professor of biology at Tufts University since 1952; dean of women and professor of biology at the College of William and Mary, 1947–52; formerly taught zoology at the University of Missouri and had been assistant professor of zoology and comparative anatomy at Duke University; 15 May.

GRANTLY D. READ, Wroxham, England; 69; pioneer in natural-childbirth techniques; practiced gynecology in London from 1923 to 1948; set up a world center for the practice of natural-childbirth methods in Johannesburg, South Africa, in 1949; author of various books, one of which, *Childbirth Without Fear,* published in 1942, caused a controversy; 11 June.

NATHAN P. STAUFFER, Philadelphia, Pa.; 84; chief of the ear, nose, and throat department at Presbyterian Hospital for more than 25 years, and chief of the otolaryngology department of Girard College until his retirement this year; 5 June.

MICHAEL VETUKHIV, New York; 57; research associate in the department of zoology at Columbia University since 1949; helped to establish the Ukrainian Academy of Arts and Sciences in 1950 and was its president at his death; a native of Kharkov, Ukraine, he was one of the outstanding geneticists of the Soviet Union, professor at the Moscow Veterinary and Animal Husbandry Institute, and head of the Department of Veterinary Genetics of the All-Union Institute of Experimental Veterinary Science in Moscow, before coming to this country; 11 June.

ROBERT B. WYLIE, Iowa City, Iowa; 89; head of the botany department of the State University of Iowa from 1919 until his retirement in 1940; had been a faculty member for 53 years; chairman of the general section of the Botanical Society of America; vice president of Section G (Botany) of the AAAS in 1925; past president of the Iowa Academy of Science; 9 June.

Book Reviews

An Anthropological Reconnaissance in West Pakistan, 1955. With appendixes on the archaeology and natural history of Baluchistan and Bahawalpur. Henry Field. Peabody Museum, Harvard University, Cambridge, Mass., 1959. 332 pp. Illus. + plates. $9.75.

For those who are not world travelers and who, therefore, are confused by the newer political boundaries, it may be well to explain that the locale of Henry Field's latest report—West Pakistan—is on the Arabian Sea, with Iran and Afghanistan to the west and north and India, Tibet, and Sinkiang Province (Hsin-chiang) to the east and north. The parts of West Pakistan with which the report is chiefly concerned are Baluchistan, the southwesternmost province, and Bahawalpur, the eastern desert province. The two areas are separated by a series of mountain ranges coursing north and south and by the Indus River Valley paralleling the mountains.

West Pakistan became an independent political entity in 1947, largely because its population is predominantly Moslem. Also, much of its population has closer linguistic affiliations with Iran, to the west, than with India, to the east. This is true particularly of the western districts of Baluchistan, where Baluchi, an Iranian-type language, is mainly spoken, as might be expected simply from the physiographic fact that this area is an extension of the Iranian plateau. By way of contrast it can be said that the eastern province of Bahawalpur has little in common with Baluchistan except heat and aridity. Its heterogeneous population, speaking mainly a language identical with western Punjabi, ekes out an existence on the margin of the Indian Desert.

On 20 March 1955 Henry Field and his wife, accompanied by Mohammed Idris Saddiqi (an archeologist), Abdur Rauf Khan (a geographer), S. V. Rizvi (a geologist), Naeem Beg Chugtai (a zoologist), Hasham (a snake charmer), and H. A. Abidi (chief engineer and director of Food and Agricultural Organization projects in the Baluchistan States Union), landed, by special arrangement, from a steamer at Pasni on the coast of Baluchistan. The main reconnaissance began at Pasni and continued as the party traveled overland by motor to Quetta (approximately 350 miles in a direct line to the northeast, but, of course, much farther by the route traveled), arriving there on 7 April. Most of the party then went south by train to Karachi at the mouth of the Indus River, but the Fields and Mohammed Idris Saddiqi went eastward by train to Bahawalpur and spent the time between 12 and 20 April making a further reconnaissance by motor in the Kholistan area. Actually, therefore, the present bulky report covers only about one month in the field.

The route followed by the expedition is shown on nine detailed maps (enclosed in a pocket on the inside of the back cover), and it is described in chapters 5 (pages 77–100) and 7 (pages 162–177). These travel records ("traverses") are supplemented by 100 collotype plates showing scenes, cultural objects, and human types (all of the photographs were made by Mrs. Field).

It is not altogether clear from the report why these particular portions of West Pakistan were selected for exploration. Perhaps it was because Sir Aurel Stein left intriguing records of his visits there earlier in this century. Perhaps it was simply a matter of ease of access. In any case, it is evident that southern Baluchistan is important archeologically because it was the land connection between the ancient civilizations of the Near East and those of the Indus Valley and, on the other hand, that Bahawalpur is close to ancient Harappa, one of the twin cities of the Indus Valley civilization. Furthermore, the anthropometric characteristics of the present-day peoples in these parts had not been adequately recorded.

Before considering the body of the report it should be pointed out that Henry Field has been on "the track of man" (to use the title of his popular book), and of whatever else he could find, in the Near East and in adjacent regions since the late 1920's. The Pakistan volume now joins at least seven other such publications (chiefly on the anthropology of Iran and Iraq), which total more than 1500 pages of text and more than 500 plates. This work was sponsored at first by the Field Museum (now the Chicago Natural History Museum); since 1950 it has been under the sponsorship of the Peabody Museum of Harvard University.

Field is usually prepared to collect everything in sight. He himself is a physical anthropologist, so he specializes in anthropometric records of living people and brings back any available skeletal material. However, he or his associates always bring back cultural objects and specimens of the local flora and fauna. In the present report, chapter 6 (pages 101–143) deals with anthropometry, while 17 appendixes by almost as many collaborators (pages 181–279) deal with the rest of the collections, including such varied things as potsherds, old manuscripts, reptiles and amphibians, shells, insects, brachiopods, plankton, plants, drugs, agricultural implements, date trees, and camel brands.

From what has been said it should be apparent that, in addition to anthropology, many areas of science have been enriched by Field's industry as a collector. A considerable part of this industry is directed toward getting others to work for him. In the preface to the present volume he acknowledges help from more than 80 individuals and 17 libraries. He himself has combined data from these sources with his own observations to give a picture—unfortunately, not too clear a picture—of the land through which he traveled, the people who occupied it in the past, and the people who are living there at present. This, in turn, is supplemented by more than 700 references to the literature and by an index (24 pages).

The chief merit of this book is its attention to details; the chief fault is its lack of interpretations. For example, in the 17 pages of chapter 3, devoted to "Races, tribes and groups," many tribal and group names are given, and in the 43 pages of chapter 6, devoted to "The physical anthropology of the Baluchis, Brahuis and miscellanea," there are

many body measurements, but nowhere is the true racial position of the population of Baluchistan indicated. By contrast, Carleton Coon in his book *The Races of Europe* (Macmillan, 1939) neatly summarized this matter in the following words (page 431): "[The Baluchis and the Brahui] seem to be the results of a mixture between the Veddoid type isolated in the Hadhramaut, and the Irano-Afghan race to which their linguistic relatives belong. The difference between the majority of the Baluchis and Brahui and the fine type of the Hadhramaut is simply the difference between the small Mediterranean type of southern Arabia and the Irano-Afghan."

Field's findings add detail to the data available to Coon but apparently do not change the interpretation which the latter gave. Actually, Field measured only two linguistically distinct samples of the Baluchistan population: 85 Baluchis and 151 Brahuis. According to W. W. Howells, who studied the statistical data of these series (page 112), when they are compared as total populations "they are seen to differ in head length, head breadth and bigonial breadth to a definitely significant degree; possibly they differ in stature, bizygomatic diameter and the face heights as well." One would like to know whether language has been the isolate which has produced this difference in physique.

To his own series from Baluchistan, Field adds (page 115) numerous other series "compiled by Cappieri from published sources," and yet he fails to include in his enormous bibliography the pertinent references to the major contributors, Gupte and Risley. As I have already indicated, a general interpretation of these comparative data is also lacking. Incidentally, the editor has handicapped the reader in chapter 6 by placing Tables 101 to 111 between Tables 11 and 12. Thus, for example, one of the abbreviated headings in table 104 on page 118 is explained in table 12 on page 122.

As compared with anthropometry, archeology, one of the objectives of the reconnaissance, gets little attention in this report. Nowhere is the antiquity of human occupation in the areas visited made clear. F. A. Khan of the Pakistan Department of Archeology has contributed "Fresh light on the ancient cultures of Baluchistan and Bahawalpur" (appendix A). From this we learn only that "the chief characteristics [of the Baluchistan ceramic material] are those of being a monochrome black-on-pink or gray ware like the pottery of Shahi-Tump with a free style of ornament, qualities found on the pottery of Seistan and Bampur sites in Iran; and the monochrome and polychrome wares resembling Kulli pottery, which has outside parallels with the 'Scarlet ware' of Susa D and Mesopotamia. The Bahawalpur pottery, black-on-red, is undoubtedly the product of the Harappans." I am unable to provide a reliable chronological interpretation of these statements, but it is certainly safe to say that the sites mentioned by Khan go no further back than the protohistoric period. The failure of the expedition to find anything earlier than Harappa is noteworthy.

In summary, the present report, for all its impressive size, is woefully short on conclusions, being little more than a catalog of places visited and things collected. Undoubtedly, some of the new information supplied does fill a void, and it is therefore gratefully received, but the manner of its presentation does little credit either to the author, to his multitudinous collaborators, or to the sponsor and publisher.

T. D. STEWART
U.S. National Museum,
Smithsonian Institution

Safe Handling of Radio-isotopes. International Atomic Energy Agency, Vienna, Austria, 1958 (order from International Publications, 801 3rd Avenue, New York 22). 99 pp. Illus. $1.

This manual of the International Atomic Energy Agency (IAEA) is in the nature of a stop-gap publication pending the issuing by the agency of its own regulations for the use of radionuclides obtained through the agency. Thus, the recommendations incorporated in the manual stop short of specifying maximum permissible levels and wisely refer the user to the levels set by the competent authority in his country, or to those set by the International Commission for Radiological Protection where no such national levels have been set. Under the section on luminizing operations reference is also made to the relevant provisions of the International Labor Organization regarding ionizing radiations.

However, in spite of the fact that the IAEA is itself unable to recommend specific levels, the manual should prove a most valuable aid to any radiological health or safety officer in that its contents include very many sensible and well-considered sections on such matters as organization, medical supervision, monitoring, accidents and decontamination, design and use of sealed and unsealed sources, transportation, and radioactive waste disposal.

One appendix summarizes the 1954 and 1958 recommendations of the International Commission for Radiological Protection on maximum permissible levels for exposure to external radiations and for radioactive contamination of Air and water. A second appendix, in default of international agreement, sets forth the maximum permissible levels for surface contamination, as recommended by the competent authorities in France, Poland, the United Kingdom, the United States, and the U.S.S.R.

In the English version of the manual the language is unfortunately occasionally somewhat ambiguous, but this may have occurred in translation from one of the other languages (French, Russian, and Spanish) in which it is also published. On a more pedantic level it is interesting to note that the word *isotope* is used correctly once in the manual and incorrectly on almost every page. Thus, the IAEA perpetuates one misnomer in its use of "atomic" for "nuclear" energy and perpetrates another in its use of "radioisotopes"—both on the cover. It is probably necessary, however, to reconcile oneself to the continued misuse, even by scientific writers, of these two words.

From the practical point of view the recommendations are almost all wholly sound, although in one or two instances the reader is given cause to doubt. Is it, for instance, necessary in a low- or medium-level radiochemical laboratory not only to use paper towels and handkerchiefs but also always to treat them as radioactive residue? The problem of waste disposal is already assuming frightening enough dimensions!

It is unfortunate that such a valuable manual, which should be in the hands of every radiological safety officer, is so poorly bound that even a well-treated copy such as my own is falling to pieces. If this is typical its disintegration rate in the laboratory is likely to be such as to consign it, unjustly, to the short-lived-waste container.

W. B. MANN
Radioactivity Section,
National Bureau of Standards

Mirage of Health. Utopias, progress, and biological change. Rene Dubos. Harper, New York, 1959. xv + 236 pp. $4.

This book is one in a series, called "World Perspectives," designed to interpret creative forces in modern civilization. Each volume will be written by an outstanding thinker; the list of authors already announced begins with Konrad Adenauer and includes such names as Niels Bohr, Walter Gropius, Lewis Mumford, and Sarvepalli Radhakrishnan.

For this volume Rene Dubos has written a series of essays discussing various aspects of health. The essays present an amazing number of delightful and often historical glimpses, interpreted and connected by the author's ranging comments.

The first chapter, "The gardens of Eden," tells rather whimsically what man does when he is convinced that he will be healthy as long as he stays close to nature. Thus, Western man is described as believing in the holiness of seminudism and raw vegetable juice. In the next section, on biological and social adaptation, there is further discussion of the relationship of society to nature. Dubos says: "In a wise society leisure . . . should play a role similar to that of national parks and wild life reservations, where plants and animals retain some chance to practice the mechanisms which have permitted evolutionary adaptation.

"Struggle and partnership in the living world" tells how man early achieved mastery over ferocious animals but not over microbes; the latter are still generally thought of as bad, though it is pointed out that this is an anthropocentric judgment and that in fact some microbes are good, even for man. When man meddles with nature, whether with animal predators or with bacteria in the intestine, it is risky. Even from the microbe's standpoint, partnership is desirable, for when a parasite's host is killed the parasite's own survival is jeopardized.

Under "Environment and disease" and "Hygeia and Asclepius," the recurring theme is the fallacy of trying to determine specific causes. The partial conquest of tuberculosis, cholera, syphilis, and many other infectious diseases is easily ascribed to new drugs, but better sanitation, better nutrition, and the like are of greater significance. Dubos says, "The introduction of inexpensive cotton undergarments easy to launder and of transparent glass that brought light into the most humble dwelling, contributed more to the control of infection than did all drugs and medical practices."

There is a general impression that diseases remain more or less unchanged in character over long periods of time, but, in fact, they are constantly changing, especially in a population not previously exposed. Also, when one disease is rooted out, another is likely to take its place. Some of the most stimulating passages in the book appear in the section on social patterns of health and disease. The highly organized social structures of today are set up to provide security from birth to death, but "this security is often bought at the price of boredom." Danger, real or imaginary, used to provide the exhilarating unexpected. Man needs strife and adventure, for he cannot escape his biological past. These thoughts carry the reader on to the chapter on the effects of disease on populations and civilization, where it is epigrammatically stated that "to save people from death by measures of public health is . . . easy, but no solution is in sight for the problems created by their survival." A sidelight on the vital problem of population shows the political implications. In former times the majority of the population was youthful and eager for economic expansion; now, suddenly, the average age has risen and continues to rise, and the concern of the majority is with problems of security and retirement.

The final section, on utopias and human goals, suggests that we may rediscover merit in Plato's philosophy when the world becomes crowded with the aged, the ill, and the defective. In the past the scientist has been happily occupied with his discoveries, descriptions, classifications, and inventions, but now he is being called to account for the long-term consequences of his acts. This calls for a new alertness and ability to predict oblique courses, for man will not revert to an arrested, antlike society. Certain men will always have goals which transcend simple biological purpose. They are not looking for paradise, because paradise would be static. Man requires adventure.

This book will be a treat for readers, and it will make them think.

WINDSOR CUTTING
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Southeastern Indians, Life Portraits. A catalogue of pictures, 1564–1860. Emma Lila Fundaburk, Ed. The Editor, Luverne, Ala., 1958. 136 pp. Illus. $7.50.

This book, a companion volume to the earlier *Sun Circles and Human Hands,* brings together 354 pictures. Many are portraits of noted individuals, while others depict the modes of life, customs, and clothing of the historic Indians of the southeastern United States. The illustrations were judiciously selected from the drawings and paintings of many European, colonial, and American artists and from later lithographs and engravings. The pictures are carefully identified and are arranged chronologically by artist. They are discussed in extensive notes, in which pertinent historical information is presented, together with observations about the life and works of the various artists. The sources of the pictures are listed; there is an index of artists, engravers, and authors, as well as a subject index.

Emma Fundaburk has made a valuable contribution to ethnography in making available in one volume so many pictures that are a basic source of information for students and others interested in the southeastern Indians. In addition to many of the better known ones, she presents a number of pictures that previously had been seen by only a few ethnologists.

This book and the preceding volume, about the prehistoric Indians, give all the material that is essential for a good understanding of the aboriginal Americans in the southeastern United States.

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Fishes of the Great Lakes Region. Bull. No. 26. Carl L. Hubbs and Karl F. Lagler. Cranbrook Institute of Science, Bloomfield Hills, Mich., rev. ed., 1958. xi + 213 pp. Illus. + plates. $5.

This compact and accurate book gives descriptive keys and illustrations of the various fishes, now known to total 234 species and subspecies, in the Great Lakes and their tributaries. The introductory pages give pertinent accounts of zoogeography, glaciation, anatomy, and methods of study related to fishes of this region. Comments about distri-

bution of many of the fishes form an important part of the book.

The first edition was used in many colleges and universities, and by fishery biologists; this has enabled the authors to produce a nearly perfect second edition, in which great confidence may be placed. However, in the section on "Methods of counting fin rays," one is led to believe that the definitions given for (i) "principal and branched rays" and (ii) "last ray of dorsal and anal fins" are generally accepted. That is not the case, however, for many prominent ichthyologists (i) do not distinguish the "principal ray" but record separately each simple and branched ray and (ii) count and record each fin ray that has a separate base for both the dorsal and anal fins. In a few places in the key one still finds vaguely defined contrasting characters, such as "mouth more oblique, making an angle of decidedly less than 60 degrees . . ." and "mouth less oblique, making an angle of little less than 60 degrees . . ." Of course, in a fauna as complicated as the minnows of the Great Lakes, perhaps some vagueness is unavoidable and I do note that much of the vagueness of the earler version has been removed.

This book is a must in every biological laboratory where there is interest in the zoology of the Great Lakes region. It is an excellent contribution to ichthyology.

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Nationalism in Colonial Africa. Thomas Hodgkin. New York University Press, New York, 1957. 216 pp. $3.75.

There is mounting evidence to support the proposition that the fundamental political issue of the 20th century will not necessarily turn out to be the cold war and all it stands for. The fundamental issue may well be found in the problem of whether the more advanced, industrial societies, at present still the masters of science and technology, will succeed in associating in mutually beneficial partnership with the less developed but rapidly evolving new societies of Asia and Africa. That the ideological struggle and its associated power politics are likely to have a very direct bearing upon the ultimate nature of any such association makes our need for a more precise understanding of that process of evolution all the more urgent.

Over the years, Western scholarship in the social and cultural sciences has built up an impressive body of findings on Asia. Especially in this country, there has been until very recently no comparable concern with studies of Africa. This was largely due to the fact that, virtually until World War II, Africa's social and political problems were seen primarily from the point of view of the colonial powers and their holdings. With the passing of the old order in Africa, American policy makers and American scholarship have become aware of the African challenge. At an incredible pace, a new African society is coming to life, amid explosive political upheavals, with the advent of newly self-governing communities and with the growing realization, both in Africa and elsewhere, that peoples in widely separated areas of the continent are developing a sense of interdependence and kinship—a process that is stimulating the growth of a new and vigorous African leadership, of which Kwame Nkrumah of Ghana is a good example.

Hodgkin's book, a sample of British scholarship in this field, is a searching study of the new nationalism found throughout colonial and recently colonial Africa. The author does not fail to recognize the problems of terminology in this context—(what *is* an African nation?) and concludes that for his purpose nationalism can be suitably defined as the explicit assertion by any group "of the rights, claim or aspiration of a given African society . . . in opposition to European authority, whatever its institutional form and objective." Equipped with a broad grasp of realities, the author starts out by presenting a significant comparative analysis of the policies of the three principal colonial systems which have largely fashioned the matrix of modern Africa. Despite the characteristic differences between the several colonial environments, the national movements throughout Africa have, in Hodgkin's view, a great deal in common. His examination of certain focal aspects of contemporary African life very effectively demonstrates the value of his hypothesis. His analysis of the new urban communities brings out their function as the cradle of a new African middle class. The formation of a broad variety of new African organizations is shown to be a way of blending new experiences with the older traditions. Attention is given to the role of Christian sects, illustrative of the general religious life, and to the connection of these sects with nationalist attitudes, as well as to the generally moderating influence of trade unionism and the growth of political organizations among Africans. Specialists and general readers alike will be stimulated by a chapter devoted to the search for effective myths and symbols with which the new nationalists, like their Western precursors, seek to invest themselves.

Hodgkin concludes that the rapid tempo which has marked the growth of African nationalism is unlikely to diminish, since the factors responsible for this growth (urbanization, educational advances, and so forth) continue to operate. Whether these movements will employ violence or nonviolence—revolutionary or constitutional methods—will, in his opinion, largely depend on "the attitudes of the colonial regimes, the flexibility of their policies, their willingness to make substantial political concessions." The book, originally published in England in 1956, has lost nothing of its value in the interim. It impresses me as being one of the most balanced and most illuminating studies yet made of this complex political process and its social setting. It may even persuade the skeptic of the possibility of meaningful generalization in this area.

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Plant Nematodes. Their bionomics and control. Jesse R. Christie. Agricultural Experiment Stations, University of Florida, Gainesville, 1959. xi + 256 pp. $3.75.

Among the subdivisions of modern biology, plant nematology casts a feeble, though increasingly strong, light. Although nematodes have been known to zoologists for some years—especially to parasitologists, who have studied nematodes of man and domestic animals—most zoologists neglect the study of marine and soil nematodes. Prior to 1940 a handful of workers had succeeded in convincing only a few agriculturists of the importance of these pests. But once a practical method of killing eelworms in field soil had been developed and it had been demonstrated that remarkable increments of crop growth follow such

treatments, many growers were convinced that soil-inhabiting nematodes are an important burden to plants.

Small groups of plant nematologists are active in various parts of the world, the largest number being in the United States. California has the only university department of nematology, so termed, at the graduate level, but a growing number of universities include specialists in nematology in their plant pathology and entomology departments. Publication of the first American book devoted exclusively to plant nematodes is therefore an event.

Christie is the dean of experimental agricultural nematology in the United States. His book discusses each of the known plant-parasitic nematodes in turn, presenting a well-illustrated and careful compilation of information useful to a wide audience. The book includes no taxonomic keys; it strongly emphasizes life history, injury to plants, and methods of control. The literature citations are adequate.

Plant nematology is at an exciting moment in its history. Study of the subject is gradually gaining support, both from government and in universities. The great complexity of the relations between host and parasite makes it imperative that we employ the full resources of modern biology to achieve the necessary understanding for manipulating these relationships. Christie's book shows the tremendous variety of the nematodes parasitic on plants; it will ease the task of all who seek to become acquainted with these forms.

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A Method of Anatomy. Descriptive and deductive. J. C. Boileau Grant. Williams and Wilkins, Baltimore, Md., ed. 6, 1958. xxv + 879 pp. Illus. $11.

Since its original publication in 1937, this book has enjoyed great popularity, and countless numbers of beginning medical students have found it helpful in gaining some understanding of human gross anatomy. The body is considered by regions, rather than by systems as in the larger, standard texts; hence this book in some degree combines the functions of a simplified text and a dissecting manual. It is intended to be, in the words of the author, "a working instrument designed to make Anatomy rational, interesting and of direct application to the problems of medicine and surgery."

The text of this newest, sixth edition has been considerably revised, and this involved deletions as well as additions. However, the character of the book has not been altered. The most striking change is in the use of the new international anatomical nomenclature, or N.A.P. (Nomina Anatomica Parisiensia), which was accepted by the sixth International Congress of Anatomists at Paris in 1955. Happily, however, where the newer terminology differs substantially from that previously in general use, the older B.N.A. (Basle Nomina Anatomica) or B.R. (Birmingham Revision) terms are also given in brackets. Parenthetically, it is to be hoped that international adoption of the N.A.P., even though the new nomenclature may be inadequate in some respects, will put an end to the unprofitable tinkering with anatomical terminology that has plagued anatomists during the past quarter-century.

The illustrations, all in black-and-white, number 862; of these, 34 are new. Many of the figures are clever diagrams which are quite useful to the student. In general, however, the illustrations are so simplified or even schematic that the book can be most profitably used only in connection with an anatomical atlas.

A useful list of nearly 200 references is appended. This has been kept up to date: 71 are of the last decade, and 36 have been published since the previous edition—hence, since 1952. Regrettably, however, all save four are references to books or papers written in English, and of these, two are cross-references to translations of French publications. Admittedly, the American medical student (and, evidently, his Canadian counterpart as well) shrinks from contact with anything written in a foreign language. Yet it may be questioned whether the anatomist, of all people, with the roots of his science extending back into antiquity, should wittingly acquiesce in and even contribute to the increasing debasement of the humanistic aspects of medicine.

No book can be entirely satisfactory to everyone. In any event, this book is one of the best of the shorter gross-anatomy texts now available in the English language. Its continued popularity seems assured, particularly in view of the current trend toward drastic curtailment of the time devoted to anatomy in the medical curriculum. Under these conditions, a shorter text of this sort is especially valuable.

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The Chemistry and Physics of Clays and Other Ceramic Materials. Alfred B. Searle and Rex W. Grimshaw. Interscience, New York, ed. 3, 1959. 942 pp. Illus. $16.25.

The appearance, after 25 years, of a third edition of this standard reference volume on the composition and properties of clays will be welcomed enthusiastically by everyone who has any interest in clays and soils. As stated in the preface of the second edition, the object of the authors was to select and coordinate all important facts that appertain to the chemistry and physics of clays and allied materials. It would be impossible for anyone to attain completely such an objective, but the authors are to be congratulated on having come very close to it.

The first chapters in the volume are concerned with the atomic structure of the components of clay materials and with methods of identifying and analyzing these components. These are followed by many chapters which are concerned with the physical properties of clay materials, and the authors are especially concerned with the theories that have been advanced to explain these properties. Throughout the book consideration is given to the occurrence of various types of clay materials, and a brief historical discussion of ceramics is presented at the beginning of the volume. The book is very clearly written and remarkably free from errors. There is a considerable amount of repetition—for example, in the consideration of the characteristics of clay-water systems—but this is perhaps unavoidable in a volume of this kind.

In a volume of this magnitude every serious student of clays is bound to find some statements with which he disagrees. Thus, I am not in accord with all the statements made concerning bentonite, chert, and ball clays.

The volume could have been substantially shortened if many of the trivia

had been omitted; these in most cases are concerned with simple details which are common knowlede to everyone with any interest in clays and soils. A single example (many can be given) is the detailed discussion of the process of sieving; this could have been shortened or even eliminated.

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New Books

Annual Review of Medicine. vol. 10. David A. Rytand, Ed. Annual Reviews, Palo Alto, Calif., 1959. 455 pp. $7. Contents: "Infectious diseases (some aspects of salmonellosis)," I. L. Bennett, Jr., and E. W. Hook; "Gastroenterology," J. B. Kirsner, J. E. Dooley, G. E. Scott, S. C. Kraft; "Diseases of the cardiovascular system (excluding hypertension and atherosclerosis)," F. D. Johnston; "Cardiovascular diseases (atherosclerosis)," W. Dock; "Diseases of the cardiovascular system (surgical)," D. E. Harken and W. J. Taylor; "Nutrition and nutritional diseases," G. H. Berryman; "Endocrinology (diabetes)," H. T. Ricketts; "Endocrinology (reproduction)," R. L. Landau; "Endocrinology (surgery of the endocrines)," J. D. Hardy; "Allergy and immunology," W. B. Sherman; "Neoplastic diseases (cancer)," C. Oberling; "Neoplastic diseases (tumor chemotherapy)," R. L. Clark, Jr., and W. W. Sutow; "Diseases of the nervous system," R. N. DeJong; "Psychiatry," T. A. Gonda; "Special therapeutics (transfusions)," S. C. Finch; "Diseases of the skin," S. W. Becker, Jr.; "Pediatrics (noncardiac anomalies)," M. M. Ravitch and R. J. Wilder; "Diseases of the respiratory system," R. S. Mitchell and G. C. Bower; "Environmental medicine," R. A. Kehoe, L. H. Miller, A. Davis, M. Zavon.

Automation and Society. Howard B. Jacobson and Joseph S. Roucek, Eds. Philosophical Library, New York, 1959. 553 pp. $10.

Beginners' Book of Astronomy. John Sternig. McBride, New York, 1959. 162 pp. $3.75 (juvenile book).

College Physics. Franklin Miller, Jr. Harcourt, Brace, New York, 1959. 623 pp. $7.25.

Concise Dictionary of Science. Physics, mathematics, nucleonics, astronomy, chemistry. Frank Gaynor. Philosophical Library, New York, 1959. 546 pp. $10.

DDT. The insecticide dichlorodiphenyltrichloroethane and its significance. vol. II. Paul Muller, Ed. Birkhauser, Basel, Switzerland, 1959. 570 pp. F. 66.

The Dentition of the Growing Child. A longitudinal study of dental development between 3 and 18 years of age. Coenraad F. A. Moorrees. Harvard Univ. Press, Cambridge, Mass., 1959. 253 pp. $5.50.

Developmental Cytology. Dorothea Rudnick, Ed. Ronald Press, New York, 1959. 220 pp. $7. Contents: "Nuclear and cytoplasmic differentiation in the protozoa," J. R. Preer, Jr.; "Quantitative chromosomal changes and differentiations in plants," C. R. Partnen; "Numerical variation of chromosomes in higher animals," T. C. Hsu; "Nuclear and cytoplasmic changes in tumors," G. Klein and E. Klein; "Chromosomal differentiation in insects," W. Beermann; "Changes in nucleoli related to alternations in cellular metabolism," H. F. Stich; "Developmental changes in chloroplasts and their genetic control," D. von Wettstein; "Changes in the fine structure of the cytoplasmic organelles during differentiation," D. W. Fawcett; "Metabolic interactions in cell structures," A. L. Lehninger.

Directory of Periodicals Published by International Organizations. Union of International Associations, Brussels, Belgium, ed. 2, 1959. 251 pp. $3.

Electric Motors and Generators Illustrated. An up-to-date practical guide for all those interested in the generation and application of electricity. E. T. G. Emery *et al.* Philosophical Library, New York, 1959. 384 pp. $12.

Excursion Flora of the British Isles. A. R. Clapham, T. G. Tutin, E. F. Warburg. Cambridge Univ. Press, New York, 1959. 612 pp. $4.50.

Experimental Techniques in Low-Temperature Physics. Guy Kendall White. Oxford Univ. Press, New York, 1959. 246 pp. $7.20.

Fundamentals of Physical Chemistry. H. D. Crockford and Samuel B. Knight. Wiley, New York; Chapman & Hall, London, 1959. 481 pp. $6.95.

General Circuit Theory. Gordon Newstead. Methuen, London; Wiley, New York, 1959. 151 pp. $3.

The Geochemistry of Rare and Dispersed Chemical Elements in Soils. Translated from the Russian. A. P. Vinogradov. Published for the Geochemical Soc. by Consultants Bureau, New York, 1959. 209 pp. $9.50.

Group Theory. And its application to the quantum mechanics of atomic spectra. Eugene P. Wigner. Translated from the German by J. J. Griffin. Academic Press, New York, expanded ed., 1959. 383 pp. $8.80.

Handbuch der Physik. vol. 52, *Astrophysics III: The Solar System.* S. Flügge, Ed. Springer, Berlin, 1959. 608 pp. DM. 148.

Index Kewensis, Plantarum Phanerogamarum. 1951–1955. George Taylor, Ed. Oxford Univ. Press, New York, 1959. 162 pp. $12.

Junior Colleges and Specialized Schools and Colleges. Porter Sargent, Boston, Mass., ed. 3, 1959. 448 pp. $5.

Mechanical Man. Beril Becker. Putnam's, New York, 1959. 192 pp. $2.95 (juvenile book).

Methods of Biochemical Analysis. vol. 7. David Glick, Ed. Interscience, New York, 1959. 362 pp. $9.50.

Methods of Experimental Physics. vol. 1, *Classical Methods.* Immanuel Estermann, Ed. Academic Press, New York, 1959. 608 pp. $12.80.

A Modern Introduction to College Mathematics. Israel H. Rose. Wiley, New York; Chapman & Hall, London, 1959. 551 pp. $6.50.

Orthogonal Functions. G. Sansone. Translated from the Italian by Ainsley H. Diamond. Interscience, New York, rev. English ed., 1959. 423 pp. $11.

Plane Trigonometry. Nathan O. Miles. Wiley, New York, 1959. 245 pp. $3.95.

The Rainbow. From myth to mathematics. Carl B. Boyer. Yoseloff, New York, 1959. 376 pp. $10.

The Romance of Chemistry. From ancient alchemy to nuclear fission. Keith Gordon Irwin. Viking, New York, 1959. 159 pp. $3.75.

The Story of the Plant Kingdom. Original edition by Merle C. Coulter; revised by Howard J. Dittmer. Univ. of Chicago Press, Chicago, 1959. 335 pp. $5. The original version was written in 1935 to serve as a textbook in botany under the new Chicago College Plan. The text was used in that division of the plan called "Introduction to Biological Sciences."

Strong and Elwyn's Human Neuroanatomy. Raymond C. Truex. Williams & Wilkins, Baltimore, Md., ed. 4, 1959. 524 pp. $10.

They Explored! Humboldt, Livingston, Fremont, Hedin, Scott, Herzog. Rhoda Hoff and Helmut de Terra. Walck, New York, 1959. 120 pp. $3.25.

Treatise on Invertebrate Paleontology. Part O. Arthropoda 1: Arthropoda—general features, Protarthropoda, Euarthropoda—general features, Trilobitomorpha. Raymond C. Moore, Ed. Univ. of Kansas Press, Lawrence, 1959 (order from Geological Soc. of America, New York). 579 pp.

Uranium and Other Miracle Metals. Fred Reinfeld. Sterling, New York, 1959. 128 pp. $3.95.

Virus Growth and Variation. Ninth symposium of the Society for General Microbiology held at the Senate House, University of London, April 1959. Cambridge Univ. Press, New York, 1959. 278 pp. $7. Contents: "Viruses: a survey of some current problems," S. E. Luria; "Growth of bacteriophage," E. Kellenberger; "The multiplication of viruses in plants," B. D. Harrison; "Some observations concerning the reproduction of RNA-containing animal viruses," W. Schafer; "Studies of mixed infections with NDV, poliovirus and influenza," G. K. Hirst; "Viral interference," A. Isaacs; "Growth of bacteriophage," E. Kellenberger; "The multiplication of viruses in plants," B. D. Harrison; "Some observations concerning the reproduction of RNA-containing animal viruses," W. Schafer; "Studies of mixed infections with NDV, poliovirus and influenza," G. K. Hirst; "Viral interference," A. Isaacs; "Host-controlled variation in animal viruses," J. M. Hoskins; "Growth studies with Herpes virus," M. G. P. Stoker; "Special interactions between virus and cell in the Rous sarcoma," H. Rubin; "Studies on vaccinia virus in HeLa cells," H. B. Maitland and R. Postlethwaite; "The chemical approach to the study of animal virus growth," P. D. Cooper; "Fluorescence microscopy: observation of virus growth with aminoacridines," E. S. Anderson, J. A. Armstrong, J. S. F. Niven; "Electron-microscopic observations on adenoviruses and viruses of the influenza group," C. Morgan and H. M. Rose.

Reports

Parasitic Conifer Found in New Caledonia

Abstract. A rare and unusual species of *Podocarpus* from New Caledonia was collected and discovered to be parasitic on another conifer. The attachment is by modified roots imbedded between the cork cambium and the vascular cambium. A parasitic gymnosperm is something new to science.

The interesting species, *Podocarpus ustus,* has always occupied a unique position in its genus and family, and among conifers in general. It grows in remote, densely forested highland parts of New Caledonia. It has rarely been collected and has probably never been studied in the field by any competent scientist. The closest to field study was achieved by J. B. Hair of New Zealand, who succeeded in having fresh specimens brought to a field laboratory where he was making chromosome determinations. Its uniqueness has derived from the fleshy deep red or purple scale-leaved branches that have the uncooperative habit of disintegrating into minute fragments when preservation is attempted. *Podocarpus ustus* is the single member of the section *microcarpus* of the over-sized genus *Podocarpus.* In reproductive structure it is a reasonably typical member of the family Podocarpaceae.

Because of the special interest which *P. ustus* has aroused, a special effort was made during a December 1957 visit to New Caledonia to collect the elusive plant. One of its areas of occurrence was visited, and several plants were seen. This report derives from the fact that one of these plants was growing out of the base of a tree of *Dacrydium taxoides.* As might be suspected from the fleshy red nature of *P. ustus,* it is a parasite, certainly sometimes, probably always. The parasitic specimen was collected and has been the subject of a careful study.

Podocarpus ustus is a woody shrub. In the case of its attachment to *D. taxoides,* the largest of two emerging stems had a diameter of about ½ inch and the host had a diameter of about 3 inches. The parasitic stem curves sharply so that the root zone is oriented upward. Most of the woody roots travel up the trunk of the host, probably for several feet; a few grow downward for several inches. The modified roots are imbedded in the bark between the cork cambium and the vascular cambium. General stimulation of the vascular cambium has occurred, producing a thickening in both wood and bark tissue. The cambium of the slightly anastomosing roots, significantly, is on the outside toward the cork cambium. No normal phloem is produced, although a tissue full of sclerids opposite the xylem may represent modified phloem tissue. Around the parasitic roots, the host tissue is somewhat disorganized and forms a sheath of abnormally large cells.

In several ways the specimen of *P. ustus* reported here is not typical. No other specimen has been seen growing from the trunk of another plant. Typically *P. ustus* grows on the open forest floor under rather shady conditions (chlorophyll is present in the leaves). Probably most individuals are root parasites. Several attempts by foresters in New Caledonia to dig up small specimens for transplanting resulted in immediate death of the specimens. It was noticed that removing the specimens involved cutting out various tree roots, but, because a parasitic attachment was not expected, it was not looked for. Although *D. taxoides* is closely related to *P. ustus,* it may not be the preferred host. *Dacrydium taxoides* is common throughout the highlands of New Caledonia, and the rareness of *P. ustus* might seem puzzling. Lumbermen say that the densest stands of this peculiar species occur in association with an undetermined plant which, by its description, may belong to the Cupressaceae. Thus the preferred host of *P. ustus* may possibly be a rare and perhaps unnamed conifer.

It must be remembered that *P. ustus* is not necessarily always parasitic. The possibility of root grafting, a common phenomenon among conifers, may explain the entanglement of roots that has been observed. However, the single specimen upon which this report is based shows unmistakable parasitic modifications. There is no fusion of tissues as in grafting. The xylem strands run through the host phloem. These modified root strands do not show radial symmetry, but do show polarity with respect to the host. That parasitism may well be normal in this species, then, is inferred from the definite modifications that have been made for parasitic attachment, together with the general habit of this species which strongly resembles that of known root parasites. In the observed specimen, a seed has lodged against a trunk instead of over a root.

Until now, all conifers were known to be independent trees, bushes, or trailing shrubs. *Podocarpus ustus,* in being parasitic, thus differs from all other conifers. In fact no gymnosperm of any kind has previously been discovered in a parasitic relationship to other plants.

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9 March 1959

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Origin of Tektites

Barnes, Kopal, and Urey (*1*) have recently criticized the idea originally advanced by Nininger (*2*) and later discussed by Gold, Varsavsky, and me (*3*), that tektites originated as secondary bodies from the infall of meteorites on the moon.

The principal criticism of Nininger's hypothesis was one stated earlier by Urey (*4*), who argued that the tektites could not have arrived at the vicinity of the earth as a swarm, since a swarm of the necessary size and density would be gravitationally unstable at the earth's distance from the sun. Urey considered that the tektites could not have arrived as a compact mass, since this mass would be distributed over an area a few tens of kilometers in diameter, while the australite fall covers an area thousands of kilometers in diameter.

If, however, we admit the possibility that the tektites fell from nearly circular orbits around the earth, as suggested by O'Keefe (*3*) and La Paz (*5*), then this difficulty largely disappears. The tektites were conceived as spiraling into the

earth's upper atmosphere in a compact, gravitationally stable mass, which was broken up by differential drag during the last few orbits before the tektites fell. The fall would thus closely resemble the phenomena of the meteor procession of 9 February 1913, for which Chant (*6*) and others postulated a nearly circular satellite orbit around the earth. Breakup of the larger bodies of this shower was directly observed.

A nearly circular satellite orbit will have one or two sections, which might be called "active regions," from which meteorite falls are likely to occur. If the orbital eccentricity is greater than the earth's ellipticity (about 0.003), the body will approach the earth most closely at perigee. If the orbit is very nearly circular, the closest approach will be at the nodes, because of the equatorial bulge.

At any instant, the falls from the active region will occur along an arc of a great circle, where the orbit reaches its lowest point in the atmosphere. In the case of the 1913 shower, this seems to have been the region from about Port Huron, Mich., to Wilkes-Barre, Pa., according to the work of Chant (*6*) and Mebane (*7*); detonations were heard in this region.

Within a few minutes, however, the earth will turn perceptibly under the active region; and thus the strewn field will be widened in longitude. Mebane records one direct observation of this phenomenon by the weather bureau at Alpena, Mich.

It is interesting to notice that this hypothesis furnishes a natural explanation of the fact noted by Beyer (*8*) that in the Indo-Malaysian fall, the tektites of Cambodia are much larger than those of the Philippines. The larger tektites should have a smaller ratio of drag to mass, and thus would be found west of the smaller tektites because they stayed up longer.

The explanation in terms of sedimentary rocks proposed by Barnes and Urey is difficult to reconcile with the almost total absence of water.

The explanation in terms of interstellar swarms postulated by Kohman (*9*) encounters the difficulty that once the particles had reached a state of rest, in contact with one another, the mass would be dense enough to be gravitationally stable, and would thus arrive undispersed at the earth's upper atmosphere. The limit of stability in the neighborhood of the earth is about 10^{-6} gm/cm^3. Kohman remarks that the presence of aluminum-26 and beryllium-10, in concentrations comparable with those found in stony meteorites, excludes the possibility of origin from the moon. The half-lives of these nuclides are, however, 10^6 and 2.6×10^6 years, respectively. It follows that if the tektites spiraled down to the earth in a compact swarm over a period of 10^7 years, as I have postulated, there would have been sufficient time to build up a near-equilibrium concentration such as that found by Kohman.

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5 June 1959

Induced Growth of Diapausing Silkworm Embryos in vitro

Abstract. Fully diapausing silkworm embryos (*Bombyx mori* L.) ordinarily never reach the stage of appendage formation when they are cultured singly in hanging drops. However, when they are cultured side-by-side with nondiapausing embryos, they survive longer and some even achieve appendage formation.

Embryos from fully diapausing eggs of the silkworm *Bombyx mori* do not grow in vitro even when they are cultured in an extract of nondiapausing eggs in which nondiapausing embryos grow well (*1*). This is interesting in view of the fact that spermatogonia and spermatocytes from diapausing pupae of the Cecropia silkworm can be induced to grow and differentiate by in vitro culture in the blood of nondiapausing individuals (*2*). This difference in response may reflect some basic natural difference between pupal and embryonic diapause—that is, diapause in the pupal and in the egg state.

I have had a special interest in the mechanism of termination of diapause in insects, not only from a theoretical standpoint but also from that of practical needs in sericulture, and I have recently observed during in vitro culture experiments that fully diapausing silkworm embryos grow when they are cultured side by side with nondiapausing embryos in a hanging drop.

The results of side-by-side culture experiments carried out in 1958 are summarized in Table 1. Hanging-drop cultures were made in accordance with methods described previously (*1*), except for side-by-side explanation of embryos. The egg extract used for a culture medium was prepared from diapausing eggs stored at 5°C 2 days after deposition. In this medium nondiapausing embryos showed good growth when cultured singly, and all but two of 50 embryos reached the stage of appendage formation within 7 days, while 72 of 83 diapausing embryos cultured alone died within 5 days without attaining appendage formation. These are results one would expect from the data published previously. A noticeable finding evident in this table is the appreciable growth, or at least increased survival, of diapausing embryos cultured side-by-side with nondiapausing embryos. In 53 of 65 such side-by-side cultures, diapausing embryos survived for more than 5 days, and in nine they reached the stage of appendage formation. This improvement in growth, or increase in survival, cannot be attributed solely to coexistence of two or more embryos in one culture, because culture of two diapausing embryos in a drop had no effect on growth or survival; in all of seven such cultures the embryos died within 5 days. In the side-by-side cultures it was not necessary for diapausing embryos to come into contact with nondiapausing embryos for

Table 1. Induced growth of diapausing embryos through side-by-side culture.

Item	No. of embryos per culture				
	1 Non-diap.	1 Diap.	2 Diap.	1 Diap. with 1 nondiap.	1 Diap. between 2 nondiap.
No. of cultures	50	83	7	60	5
				65	
Death within 5 days	1	72	7	12	0
				12	
Survival more than 5 days	49	11	0	48	5
				53	
Appendage formation	48	0	0	9	0
				9	

growth to occur, though it seemed necessary for the two embryos to be close to each other. In cultures in which the medium either had been "conditioned" by having nondiapausing embryos cultured in it for 2 days or had been prepared from nondiapausing eggs at the stage of appendage formation, there was no sign of increase in survival or growth of diapausing embryos (*3*).

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16 February 1959

Partitioning of Body Water in Sea Lamprey

Abstract. Measurements were made of the partitioning of total body water in the sea lamprey, *Petromyzon marinus*, between intracellular and extracellular compartments and the division of the latter into interstitial fluid and plasma. The apportionment of body water in agnathans is very similar to that in elasmobranchs, and both of these primitive groups differ from what is known of the more advanced teleosts.

Until a recent study of the fluid compartments of Chondrichthyes (*1*), only the body water partitioning of mammals, among the vertebrates, had received more than passing attention. Existing studies of body fluid measurements on nonmammalian vertebrates have been reviewed by Martin (*2*), Prosser and Weinstein (*3*), and Sturkie (*4*). For the class Agnatha, apparently the only fluid compartment measurement on record is that made by Welcker (*5*), who measured the blood volume of a single sea lamprey, *Petromyzon marinus*. The smaller variety of this species found in the Great Lakes has been used in this study for measurement of the fluid compartments of a representative agnathan (*6*).

Details of the methods employed have been described elsewhere (*1*). Briefly, known quantities of Evans blue (T-1824) and sucrose were injected simultaneously by cardiac puncture into the bloodstream of lampreys anesthetized with tricaine methanesulfonate, also known as M.S. 222-Sandoz (*7*). Over a period of 25 to 30 minutes, which allowed for complete circulation of the dye, samples of blood were drawn to make colorimetric comparison of the diluted dye with standard solutions for calculation of plasma volume. After a longer period (40 to 235 minutes), to allow filtration and complete equilibration of the sucrose in the plasma and interstitial (tissue) fluid, blood samples were drawn for similar calculation of the space occupied by the sucrose, which should approximate the extracellular fluid volume. The employment of more than one sample in each case allowed extrapolation of optical density readings to zero time, thus revealing the hypothetical volume before inevitable losses of dye or sucrose had taken place. The animals were dried completely in an oven at a temperature of 105°C for determination of total body water.

Twelve complete sets of results are summarized in Table 1. The animals were all of fairly large size for the freshwater variety in the Great Lakes. Four were male and eight female, but consistent differences were not detected, so sex has been disregarded. All volume values are expressed as percentages of body weight, although the original measurements were in milliliters. Specific gravity of plasma was used in converting volume to percentage of body weight for plasma and extracellular fluid, and specific gravity of blood was used for the same purpose in blood volumes. The hematocrit reading was used to calculate whole blood volume from plasma volume.

The only comparison that can be made with previous work on agnathans is with the single blood volume determination made by Welcker (*5*) on the marine variety of the sea lamprey. His value, 4.16 percent of the body weight, was about one-half of the present mean for 12 animals (8.5 percent, with a range of 6.5 to 10.9). Although this low figure may stem from an extreme individual variation, or from differences in technique, it more likely reflects the inverse relationship between relative blood volume and body size demonstrated in elasmobranchs by Martin (*2*). No effect of size is evident within the range employed in this study. No check over a large size range was possible, for the largest lamprey available weighed less than one-fourth as much as Welcker's specimen (261 g versus 1094 g). The possibility remains that there may actually be a difference in the body fluid partitioning between the marine and fresh-water varieties, possibly associated with the salinity of the habitat.

When the fluid measurements of the lamprey are compared with those of *Squalus acanthias* (*1*), a remarkable similarity becomes evident. The 75.6 percent body water of the lamprey and 71.7 percent of the dogfish are apportioned among the fluid compartments, respectively, as follows: intracellular water, 51.7 and 50.5; extracellular water, 23.9 and 21.2; interstitial water, 18.4 and 15.7; plasma, 5.5 and 5.5; whole blood, 8.5 and 6.8. Since the plasma volumes are identical, the higher blood volume of the lamprey can only be a reflection of its higher average hematocrit value (33 percent cells) than that of the dogfish (18.2 percent).

The similarity of the fluid compartments of these two relatively primitive groups is striking in view of the very low values obtained by those who have measured the plasma or blood of the more advanced teleost Osteichthyes (*2, 3, 5, 8*). The values for the latter range from about 1 to 4 percent of the body weight, with an average of approximately 2 to 2.5 percent. The only published figure for extracellular fluid in teleost fish is that of 4.0 percent (Prosser and Weinstein, *3*) obtained with the use of NaCNS in the yellow bullhead, *Ictalurus natalis*. Extensive data accumulated but not yet published by myself will raise that figure appreciably, but it will not approach that of *Petromyzon* or

Table 1. Summary of data on fluid volumes of 12 sea lampreys.

Measurement	Mean value for 12 animals	Range	Standard deviation
Weight (g)	190.0	154 to 261	9.05
Length (cm)	46.0	42 to 50	0.66
Respiration rate (per minute)	122.0	80 to 178	7.51
Pulse rate (per minute)	31.0	24 to 44	1.65
Specific gravity, plasma	1.018	1.017 to 1.019	.0002
Specific gravity, blood	1.040	1.034 to 1.048	.0014
Hematocrit (percentage of cells)	33.0	28 to 37	.87
Plasma volume* (T-1824 space)	5.5	4.1 to 7.3	.32
Blood volume*	8.5	6.5 to 10.9	.43
Extracellular fluid* (sucrose space)	23.9	20.0 to 28.7	.79
Interstitial fluid* (sucrose space minus plasma)	18.4	13.6 to 21.8	.66
Total body water*	75.6	73.7 to 79.8	.51
Intracellular fluid* (total water minus sucrose space)	51.7	46.3 to 58.0	.90

* Expressed as percentage of body weight.

Squalus. It can safely be said then that agnathans and elasmobranchs are also alike in sharing a larger extracellular fluid volume than that of Osteichthyes. Other fluid compartment data are not available for the bony fishes.

Whatever may be the physiological significance of the reduction in circulating fluid volume in bony fishes, it would appear that such a reduction is found only in this more advanced group, while the greater plasma and interstitial fluid volumes are associated with the two most primitive of the aquatic vertebrate classes.

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27 February 1959

Clay Minerals in Playas of the Mojave Desert, California

Abstract. Montmorillonite, illite, chlorite, and kaolinite in the playas of southern California are traceable directly to the source areas surrounding the basins. No evidence found in this investigation suggests that these clay minerals are unstable in the sodic or calcic saline lake environment, but this conclusion may not be directly applied to marine evaporite facies where the minerals are rich in potassium and magnesium.

In the last decade several papers have treated clay minerals in sedimentary rocks and the effect of diagenesis on clay minerals in various sedimentary environments. Several investigators (*1, 2*) have suggested that some clay minerals are changed by diagenetic processes in the marine environment, while others (*3*) have reported that clay minerals in most sedimentary rocks are primarily the product of their source and have undergone little diagenetic change even in the marine environment. Millot (*1*) suggested that the fibrous clay minerals such as attapulgite and sepiolite are formed in the supersaline environment, but Millot, Radier, and Bonifas (*4*) recently suggested that attapulgite is formed in the marine environment.

I have undertaken a study of the clay-mineral composition of playa sediments in the western United States and of the effect of the saline environment on diagenetic changes in clay minerals. The Mojave Desert and the surrounding area in southern California contain over a hundred playas ranging in size from a few acres to over 200 square miles. These lakes have a wide range in chemical character, from almost fresh water to very saline, in which deposits of calcium and sodium salts (carbonates, sulfates, halites, borates, and others) are found. Many types of source rocks surround the playa basins and furnish sediments to playas with different chemical environments. By comparing the clay mineral composition of the source rocks and the playa sediments, important data concerning the diagenesis of clay minerals in the saline environment can be obtained. Over 300 samples of sediment were taken from 45 playas and from the source material being transported into the playa basins. This report is concerned with the general conclusions of this study.

Several groups of clay minerals are present in the playas, and their identification is based on standard x-ray analytical techniques. Montmorillonite is present in all samples and ranges in abundance from one to seven parts in ten. A 10-A clay mineral described as illite (*5*) is present in every sample and ranges in abundance from two to six parts in ten. Chlorite is present in about 75 percent of the sediments of the playas and ranges in abundance from one to six parts in ten. In only one lake, Mirage (San Bernardino County), is it the dominant clay mineral, and here it makes up six parts of the total clay mineral composition in ten. Kaolinite is recognized in the sediments in twelve playas, and its abundance ranges from one to two parts in ten. All four of these clay minerals are present in some lakes. For example, in Bristol Lake (San Bernardino County), illite, montmorillonite, chlorite, and kaolinite are found in the playa muds from which halite (NaCl) is being mined. The mother liquor of Bristol Lake is rich in calcium chloride. In every playa studied, no change was seen between the clay mineral composition of the detritus being carried into the basin and the clay mineral composition of the saline muds.

The chemistry of the saline and supersaline evaporite salts in the playas of southern California is complex, but in every case the dominant cations are sodium and calcium. Magnesium and potassium are very abundant in the minerals that are precipitated as the last phases of marine evaporite deposition; however, magnesium and potassium are not in very strong concentration in any of the saline lake deposits in southern California. Therefore the conclusions of this study cannot be applied directly to diagenesis in late-phase marine evaporite deposits. Little work has been done with the clay mineral composition and variation in marine evaporite facies, but it is in marine facies that the regular interstratification of two different clay mineral structures has been found (*6*). These rare, regular, mixed-layered clay minerals are usually high in magnesium and very probably are diagenetic products (*7, 8*).

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16 February 1959

Gas Diffusion in Porous Media

Abstract. A method has been proposed for deriving a characteristic determining flow in porous systems. This characteristic combines both area and path-length factors used by earlier authors. For a gas, diffusive flow is proportional to the 4/3 power of the gas-filled porosity, and this function has been derived from consideration of the planar distribution of spherical pores and the interaction of two adjacent planes.

The flow of liquid and gas in porous solids has long received attention. In agriculture, irrigation practice and estimation of the possible significance of soil aeration in plant growth depend on accurate definition of the parameters limiting mass and diffusive flow. In the oil

industry, the permeability of porous solids is of great significance.

In both diffusive and mass flow in porous solids, the cross-sectional area available for flow and a path-length increase, or tortuosity factor, are regarded as common determinants.

Concerning diffusive flow, Buckingham (*1*), from his investigations on moist soils and some dry soils, suggested the relationship

$$D/D_0 \propto \varepsilon^x \ (x = 2) \qquad (1)$$

where D is the diffusion coefficient of the gas through the porous solid (see Penman, *2*), D_0 is the diffusion coefficient of the gas in free air, and ε is the gas-filled porosity in cubic centimeters per cubic centimeter of bed volume. Subsequently, Penman (*2*) proposed a general relationship for both dry and moist porous solids

$$D/D_0 = (1/k)\varepsilon (0 < \varepsilon < 0.6) \qquad (2)$$

where D, D_0, and ε are the same as they are in Eq. 1, and k is the tortuosity factor and equal approximately to $2^{1/2}$. Over the range stated, Penman's data fitted the linear relationship

$$D/D_0 = 0.66\varepsilon \qquad (2a)$$

that is, k remained constant for a number of porous materials both wet and dry, but evaporative loss of water during experiments on wet soils could lead to overestimates of D/D_0 values at low gas-filled porosities.

The area "available" for flow in porous systems may be related to the pore volume distribution thus

$$A/V = (n^2\pi r^2/n^3\pi r^3)(k_1/k_2) \qquad (3)$$

where A is the area of pores, V is the volume of pores, n^3 is the number of pores per unit volume, r is the pore radius and k_1, and k_2 are characteristics of the pore shape.

If the number of pores per unit volume is n^3, then the number encountered in section is n^2 and in length, n. In general, flow theory for porous media has neglected this concept of spatial distribution of pores in length, area, and volume.

From Eq. 3 it can be shown that area A of pores "available" for flow per unit area is

$$A \propto \varepsilon^{2/3} \qquad (4)$$

The probability of continuity of pores in adjacent planes (Childs and Collis-George, *3*) further determines the operative flow area per unit area and thus

$$D \propto (\varepsilon^{2/3})^2 \propto \varepsilon^{4/3} \qquad (5)$$

For a porous solid with pores of radius $r_1 > r_2 > r_3 > \ldots r_m$ comprising m equal-volume porosity components (see Marshall, *4*), summation gives

$$D/D_0 \propto m^2(\varepsilon^{4/3}/m^2) \qquad (6)$$

This expression will apply to all dry isotropic porous solids.

When liquid is included in the porous solid, the effective area for diffusive flow of a sparingly soluble gas is determined by the number of pore classes drained—that is, gas-filled pore space such that

$$D/D_0 \propto n^2(\varepsilon_1^{4/3}/m^2) \qquad (7)$$

where ε, the total porosity, is made up of m equal-volume components of which n are drained and

$$\varepsilon_1 = n\varepsilon/m$$

Assuming the pores approximate spheres,

$$D/D_0 = n^2(\varepsilon_1^{4/3}/m^2) \qquad (7a)$$

and k_1 and k_2 of Eq. 3 do not greatly affect the result.

There is therefore a characteristic relationship between D/D_0 and gas-filled porosity for each value of total porosity in porous solid-liquid-gas systems.

In the problem of vapor transfer in a porous solid-(liquid-vapor)-gas system, the vapor flow is largely determined by the area of the liquid-gas interfaces, which is a function of

$$[2n(m-n)/m^2]\varepsilon^{4/3} \qquad (8)$$

Returning to the tortuosity factor of Eq. 2 for dry, porous solids and steady diffusive flow,

$$D/D_0 = 1/k_3\varepsilon = \varepsilon^{4/3}$$

and

$$k = 1/\varepsilon^{1/3} \qquad (9)$$

This treatment endows k with characteristics of length and is an index of the number of pores per unit length.

In Figs. 1 and 2 comparisons are given between experimental results and the theory proposed here. The data of Taylor (*5*) are mean values based on materials with similar total porosity (varying between 0.47 and 0.53 cm³/cm³). In computed curve *a* (Fig. 2), which approximates the data of Taylor, no change in ε was made as the water content changed.

In curve *b* (Fig. 2), the computation was made with appropriate variation in ε with water content. It is considered that curve *b* represents the true theoretical relationship between D/D_0 and gas-filled porosity and that the apparently reasonable agreement between Taylor's data and curve *a* is fortuitous. Taylor's data are suspect, for appreciable flow occurred through some of his materials where the water content, expressed as cubic centimeters per cubic centimeter, exceeded the total pore space of the material—for example, with quartz sand of apparent density of 1.60 g/cm³, the total porosity is 0.394 cm³/cm³ and gas flow occurred when the water content was given as 0.480 cm³/cm³. Curve *a* was inserted at first because there was some

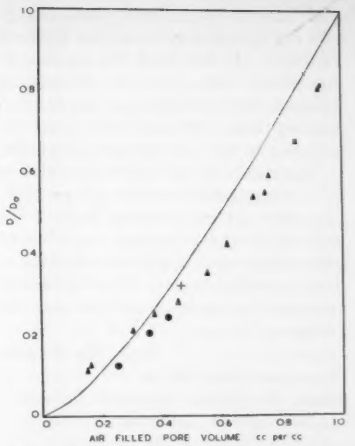

Fig. 1. Gas diffusion in dry, porous solids—a comparison of experimental results [Penman (*2*), triangles; Taylor (*5*), cross; and Van Bavel (*8*), circles] with $D/D_0 = \varepsilon^{4/3}$.

doubt about the value of ε adopted for gas flow in wet porous solids, and because the agreement of curve *a* with Taylor's data appeared good.

In computing gas and liquid Poiseuille permeability, variation in ε with water content has been made in calculation of unsaturated permeabilities (*6*).

The curvilinear relationship between D/D_0 and gas-filled porosity is due to the nature of the change in probability of continuity of pores both when total porosity varies in dry solids and when gas-filled porosity is varied by water content in single porous systems. I published experimental data to support this in 1957 (*7*) and drew an analogy between this approach to diffusive flow

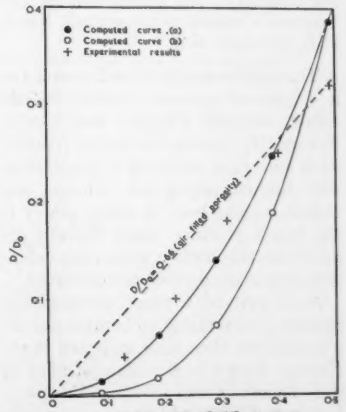

Fig. 2. Gas diffusion in a porous solid-liquid-gas system—a comparison of experimental results (Taylor, *4*) and (*a*) $D/D_0 = n^2(\varepsilon^{4/3}/m^2)$ and (*b*) $D/D_0 = n^2(\varepsilon_1^{4/3}/m^2)$.

and that of Childs and Collis-George (*3*) for Poiseuille permeability. Recently Marshall (*4*) has used this concept of two-plane interaction in determining diffusive flow; however, he has not recognized basic differences between gas diffusion in wet and dry porous systems.

The nature of the coefficients k_1 and k_2 is being considered and will probably introduce a factor varying between 0.8 and 1.2 in the end result. A value of about 0.85, when applied to the data of Fig. 1, results in very close agreement between the experimental data and the computed values.

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18 May 1959

Clay Mineral Composition of Borate Deposits and Associated Strata at Boron, California

Abstract. X-ray analyses of samples from lacustrine deposits in the Kramer borate district of California show that montmorillonite is the dominant clay mineral, and that illite is abundant in red siltstones, common in green and gray borate-barren claystones, and sparse in borate-bearing rocks. Kaolinite is present only in red siltstones. The distribution of clay minerals is related to the geologic history of borate deposition.

Throughout much of the Cenozoic era, a "boron-rich province" existed in California, southern Oregon, and western Nevada (*1*). Boron-rich waters resulting from volcanism collected in playa basins and formed segregated calcium and sodium borate beds in many places in the boron province. Such deposits are geochemically distinct from magnesium-rich borate deposits of marine origin.

As a part of a more encompassing project (*2*), samples of borates and associated lake clays were collected in the Kramer district at the open-pit mine of the Pacific Coast Borax Company, Boron, Calif. The objectives were to determine the relationships between clay minerals and borate minerals and to relate effects of environmental factors on clay mineral formation, stability, and diagenesis.

In the Kramer district (*3*) Quaternary alluvium and fanglomerates are underlain by Upper Miocene and Pliocene red playa sediments and green and gray lacustrine claystones and siltstones. Various sodium and calcium borates characterize the various layers in the lacustrine sequence, and thick beds of sodium borates are interbedded with claystone (*4*). An olivine basalt (Upper Miocene?) occurs beneath the lacustrine sediments.

Various borate minerals are associated together in specific units. Ulexite ($NaCaB_5O_9 \cdot 5H_2O$) and colemanite ($Ca_2B_6O_{11} \cdot 5H_2O$) nodules in claystone matrices are widely scattered in beds above and below the main borax-tincalconite-kernite unit. Colemanite, probably a secondary mineral after primary ulexite (*5*), is most common near the top of the borate-bearing beds. Borax ($Na_2B_4O_7 \cdot 10H_2O$), tincalconite ($Na_2B_4O_7 \cdot 5H_2O$), and kernite ($Na_2B_4O_7 \cdot 4H_2O$) occur in three main layers interbedded with claystones that collectively form a lentil about 1 mile in diameter in the center of the larger ovate sodium-calcium borate basin. Borax represents the primary precipitate, and tincalconite and kernite are secondary after borax (*5*). Less common are probertite ($NaCaB_5O_9 \cdot 5H_2O$), inderite ($Mg_2B_6O_{11} \cdot 15H_2O$), inyoite ($Ca_2B_6O_{11} \cdot 13H_2O$), howlite [$Ca_2SiB_5O_9(OH)_5$], and sassolite ($H_3BO_3$) (*6*).

Forty-five channel samples were collected from various clayey borate beds and from over- and underlying evaporite-barren beds. Borate and clay mineral compositions were determined by direct-recording x-ray diffractometer analyses by standard powder and oriented-sample techniques.

Montmorillonite and illite are, with few exceptions, the only clay minerals present, and the former is the dominant mineral in all of the samples studied. The ratio of the intensity of the unheated 10-A diffraction peak to the gain in intensity of the 10-A peak after heating to 450°C is used as a measure of the illite-to-montmorillonite ratio. Terms used to describe the amount of illite present are abundant, common, sparse, and trace, depending on whether the illite to montmorillonite ratio is 1:1 to 1:2, 1:2 to 1:4, 1:4 to 1:16, and less than 1:16, respectively. Grouping into these ratios is subject to considerable error, but it is desirable to use semiquantitative limits of some kind in order to compare relative clay mineral abundances in different rock units. Kaolinite and vermiculite-chlorite are found in trace amounts only and do not complicate the quantitative scheme.

Illite is abundant in the red sandy siltstones and is common in borate-barren green and gray claystones above and below the borate units. However, ratios of montmorillonite to illite in the barren claystones are variable, illite ranging between sparse and abundant. Illite is invariably sparse in the borate beds and associated claystones. Kaolinite is present only in red sandy siltstone and probably represents a weathering product of feldspar. A vermiculite or degraded chlorite was found in minor amounts in the upper ulexite-claystone unit.

Influx of terrigenous illite and illite-like mica apparently remained rather constant during the life of the playa lake. Increased increments of montmorillonite derived during the pulsating episodes of volcanism caused a decrease in the illite-montmorillonite ratio. The more saline volcanic waters caused clay to flocculate and permitted deposition of thick sodium borate beds. Clay entering the basin flocculated immediately and was deposited around the edges of the basin. However, during times of low salinity, clay minerals stayed in suspension longer, permitting deposition in all parts of the basin. In laboratory suspensions, flocculation occurred only in samples with high borate content.

The presence of kaolinite in the red playa sediments, as well as the absence of this mineral in underlying green and gray claystones, is noteworthy. In the latter case, kaolinite was either absent in the detritus from the source rocks (*7*) or has been altered by diagenesis to another mineral in the high *p*H environment. It is hoped that further investigation will explain the distribution of kaolinite (*8*).

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2. This project was made possible by National Science Foundation grant G-5659, and by the recipient of the grant, J. B. Droste. I am indebted to Droste for guidance; to G. S. Gordon of the U.S. Borax Research Corp., D. M. Cooper, W. H. Wamsley, and W. J. Diffley of the Pacific Coast Borax Co. for their cooperation; and to D. J. McGregor, W. N. Melhorn, and J. L. Harrison for their comments on the manuscript.
3. H. S. Gale, *Calif. J. Mines Geol.* **42**, 325 (1946).
4. Pre-Quaternary rocks referred to in this paper have been called Ricardo formation by H. S. Gale (*3*), but have recently been included in the Tropico group by T. W. Dibblee, Jr. [*Bull. Am. Assoc. Petroleum Geologists* **42**, 136 (1958)].
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6. G. L. Smith, H. Almond, D. L. Sawyer [*Am. Mineralogist* **43**, 1068 (1958)] reported an occurrence of sassolite in the Kramer district; however, I did not find this mineral.
7. Elsewhere in this issue, J. B. Droste studies the clay mineral composition of playa surfaces and concludes that the type of clay mineral present is strictly a function of source rather than a matter of diagenesis.
8. This report is published with the permission of the State Geologist, Indiana Geological Survey.

9 March 1959

Occurrence of High Ozone Concentrations in the Air near Metropolitan Washington

Abstract. Relatively high concentrations of surface ozone and the indication that ozone is the inciting agent in fleck injury to tobacco were reported previously (*1*). Considerable interest therefore attaches to weather parameters on the high-ozone days which may throw light on the source and on the physicochemical processes affecting the ozone level. A source in the direction of nearby Washington, D.C., and photochemical production of the oxidant are indicated. Days with appropriate wind direction but low peak ozone concentration are discussed in terms of coexisting weather parameters. The weather ensemble found on high-ozone days is considered in relation to instances of fleck injury for which peak ozone levels were not measured.

A continuous recorder of atmospheric ozone was operated in a tobacco field at Beltsville, Md., 6 mi northeast of the District of Columbia, from 16 Sept. to 22 Oct. 1958 (*1*). Air-intake level was 3½ ft above ground, or about 1 yd below the tops of the tobacco plants. The instrument, a prototype of model 725-2 ozone recorder of the Mast Development Corporation (Davenport, Iowa), measures coulometrically the oxidation of buffered potassium iodide solution (*2*). This instrument is being subjected to tests for specificity by other workers; our report, therefore, is based primarily on relative values of ozone concentration. These are supported by the degree of transverse cracking observed in shaded, looped strips of rubber exposed in the tobacco field daily during September at a height of 2 ft (*1*).

On 5 of 32 days of measurement, the ozone or ozone-equivalent concentration (hereinafter termed simply "ozone level") reached peak values ranging from 31 to 50 parts per hundred million (pphm) by volume (*1*). All these peaks occurred between 0955 and 1505 local standard time (EST). On four days secondary maxima were observed 1 or more hours before or after the peak. Additional data pertaining to the ozone levels have been reported previously (*1*). The daily peak levels over the whole period of record may be summarized, on a relative scale of 0 to 100, as follows: on 5 high-ozone days, the range was 62 to 100; on 27 other days, the range was 4 to 38, and on 18 of these days, the range was 14 to 24.

The 1300 EST surface weather charts for the five high-ozone days show a ridge of high pressure to the southeast or south of Beltsville and a trough of low pressure to the northwest. On two days the Washington, D.C., area was occupied by a saddle of high pressure, with the ridge line about 100 mi to the southeast or the south. On another day the ridge, which extended southwestward from a nearby center, was just east of Washington. On the two remaining days the ridge lay several hundred miles to the south or the southeast, and an approaching trough was 100 to 400 mi to the northwest.

On each of the high-ozone days, the surface winds during the 2-hour period preceding the peak ozone level were from a sector that includes the eastern portion of the Washington metropolis, south of Beltsville (Table 1). This finding is contrary to that reported in a study of ozone at a place 30 km west-southwest of Paris, where *low* levels of ozone concentration were associated with winds from the city (*3*), in the months January to June. Haagen-Smit advanced the hypothesis that ozone is formed in the photochemical reaction of nitrogen dioxide and certain hydrocarbons found in automobile exhausts and elsewhere; this hypothesis, which is supported by several chamber experiments, has been invoked to explain high levels of ozone found at times in the Los Angeles basin (*4*).

Metropolitan Washington can be classified as, at most, light industrial, and at the air temperatures dealt with there should have been little or no contribution to air pollution from domestic heating; the density of Washington automobile traffic, on the other hand, is notorious. We believe the nature of pollution sources, and particularly the absence in Washington of a "coal" atmosphere (*5*), can help to explain the difference in the occurrence of ozone near Paris and near Washington. Since no other sources of ozone in suitable strength are known (*6*), we tentatively adopt Haagen-Smit's hypothesis to explain the origin of high levels of ozone at Beltsville.

It is considered unlikely that stratospheric ozone was an important source on the five high-ozone days because the indicated ozone levels at Beltsville reached an order of magnitude higher than levels in the lower troposphere commonly attributed to downward mixing from the high-altitude source (*5*). This would still be true even though the indicated ozone levels should prove to be high by a factor of 3. The convective layer at the time of peak ozone levels at Beltsville was bounded on top by a layer of considerable stability. Analysis of the upper-air sounding for Washington indicates that on three days (26 September and 10 and 16 October) the surface-based morning inversion had not been penetrated by the developing convective layer at the time of occurrence of the peak ozone level. On the other two days (23 September and 9 October) the surface-based inversion had been dissolved, but the convective layer was bounded above by a markedly stable subsidence layer.

The District of Columbia lies in the sector south through west-southwest of Beltsville, the nearest boundary being from 6 to 9 mi away. Satellite communities and the highways converging upon the district of course subtend a somewhat broader sector. Weather parameters listed in Table 1 were examined for the 11 days when the surface wind direction within the hour preceding peak ozone level at Beltsville fell between southeast and south-southwest. No cases of south-west-to-west surface wind were encountered. The purpose was to discover why the ozone level on these 11 days failed to reach the high relative values (62 to 100) previously discussed. A comparison with values in Table 1 for high-ozone days follows: Wind speed (see *i*) was higher by at least a factor of 2 on two days; solar radiation (see *f*) was lower (range, 53 to 75 langleys) on four

Table 1. Some meteorological parameters on five high-ozone days, Beltsville, Md.

No.	Parameter and Range
	At time of peak ozone level
a.	Temperature, tobacco field, 80° to 84°F
b.	Temperature, airport, 72° to 79°F*
c.	Relative humidity, tobacco field, 54 to 66 percent
	During 2-hr period preceding peak
d.	Surface wind, airport, direction, SE to SSW*
e.	Surface wind, airport, speed, 3 to 8 knots (3 to 9 mi/hr)*
f.	Solar radiation, Silver Hill, 81 to 118 langleys
	2 Hours before peak
g.	Depth of convective layer, 200 to 4700 ft
h.	Wind near top of convective layer, direction, S to SSW
i.	Wind near top of convective layer, speed, 2 to 6 knots (2 to 7 mi/hr)
	*Daily values, airport**
j.	Maximum temperature, 78° to 90°F
k.	Average temperature, 66° to 78°F
l.	Temperature range, 23° to 29°F
m.	Precipitation, none on day of high value and on preceding day.

* Data measured at Washington National Airport, 14 mi south-southwest of Beltsville.

days; wind speed was higher and solar radiation was lower on two days; wind direction aloft (see *h*) was north of west on two days; no difference was found on one day.

Thus, dilution of precursor material for the photochemical reaction, insufficient irradiation, or wind direction aloft from a quarter other than Washington may account for the findings on 10 of the 11 days when winds at the surface were southerly but ozone levels were low at Beltsville.

While the weather parameters on the remaining day (16 September) appeared to be similar to those for the five high-ozone days, the 0600 sounding at Silver Hill, Md. (7), differed; instead of a surface-based inversion, the sounding showed a 500-ft-deep isothermal layer, with an inversion immediately above, and southwest wind of 22 knots 700 ft above the surface. The temperature in the tobacco field at 1152, the time of peak relative ozone level (34), was the highest in the period of ozone record (97°F). While the velocity rate of ozone decomposition increases rapidly with temperature (*8*), it is believed that the antecedent high wind speed aloft was the primary limiting factor in this case.

Weather-fleck injury to tobacco, of the kind previously reported at Beltsville in association with high ozone levels (*1*), was observed northeast of Hartford, Conn., on 15 Sept. 1958 (*9*). Physiological insult by ozone was presumed to have occurred the day before. Weather parameters applicable to the Hartford area on this day were found to be similar to those associated with instances of high ozone level at Beltsville (Table 1). Likewise it was found that the weather parameters for Washington, D.C., on 14 September, fell into the same ranges, if, as was assumed, the maximum ozone level occurred about 1030 (the ozone recorder was not operated on that day). Whether fleck was observed at Beltsville the following day (*1*). While the test data indicate the ranges within which certain weather parameters make possible the occurrence of high-ozone levels downwind of a metropolis, further work is necessary to establish critical limits (*10*).

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2. The ozone recorder used in this study was on loan to the U.S. Public Health Service, for test, and became available through the courtesy of C. Stafford Brandt of the Robert A. Taft Sanitary Engineering Center (Public Health Service), Cincinnati, Ohio.
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4. A. J. Haagen-Smit, *Science* 128, 869 (1958); see also C. E. Bradley and A. J. Haagen-Smit, *Rubber Chem. and Technol.* 24, 750 (1951).
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6. The amount of ozone produced by point dischargers in normal electrostatic fields would seem inadequate; however, further investigation may be warranted. See H. Cauer, "Some problems of atmospheric chemistry," in *Compendium of Meteorology*, T. F. Malone, Ed. (American Meteorological Society, Boston, 1951), p. 1126.
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10. The portion of the research reported here by Weather Bureau personnel was supported by the Public Health Service through contract with the Weather Bureau for studies of community air pollution.

27 February 1959

Molecular Structural Factors in Competitive Inhibition of Sugar Transport

Abstract. The high potency of phloretin as a competitive inhibitor of the human red cell's monosaccharide transport system is not shared by any of several molecular fragments of phloretin, but is duplicated in certain artificial estrogens resembling phloretin in respect to the spacing between terminal phenolic —OH groups. Related molecules which are slightly less extendible are comparatively inactive.

The glucoside phlorhizin, the classical agent for inducing experimental glycosuria through inhibition of sugar reabsorption in the renal tubules, similarly interferes with the passage of monosaccharides through the surface of human erythrocytes (*1*) and mouse ascites tumor cells (*2*). But the glucose moiety of the phlorhizin molecule does not appear to be involved in this action, since (at least in the red cell system) slowing of sugar transfer is much more pronounced with the aglucon (phloretin) than it is with the glucoside (*3*). The systematic manner in which the degree of this inhibition is determined by the sugar and phloretin concentrations (*4*) accords well with the mass action law as applied to a case of direct competition between inhibitor and substrate (sugar) for some "carrier" site on the cell surface.

A novel type of substrate stereospecificity has recently been reported for this sugar-transfer system (*5*), such that the critical requisite for reaction with aldoses is evidently the energetic stability of the sugar in the particular pyranose "chair" conformation designated as "C1." But both rings of the phloretin molecule are aromatic (hence essentially planar), and neither assumes any of the conformations in which the substrate sugar rings could be stable. Therefore a quite different factor must underlie the even tighter association with phloretin which is implied by the inhibition kinetics. Hence the present study (*6*) was directed toward identification within the phloretin molecule of the atomic groupings critical to the high, specific inhibitory potency, in the hope of developing a clue about the physicochemical structure at the hypothetical carrier sites.

To this end, various agents (*7*) were compared as inhibitors of the red cell's monosaccharide transport system, principally in terms of decrease in the rate of egress from the cells of D-glucose; as illustrated in earlier reports (*4*, *8*), estimation of rates is simpler with this procedure than with "entry" experiments. Washed human erythrocytes equilibrated with the sugar at about 0.15*M* were transferred, at 37°C, to a much larger volume of sugar-free medium. The relatively slow sugar exit which ensues is accompanied by rapid osmotic equilibration of the water, and the resultant cell shrinkage was followed in the very dilute cell suspension by continuous optical densitometry (method of Ørskov, *9*). The usual medium was a mixture of the chlorides of Na, K, Ca, and Mg in a molar proportion of about 150:6:3:2 and at a total tonicity of 300 to 305 milliosmole/lit. when buffered at *p*H 7.4 with 32m*M* tris(hydroxymethyl)-aminomethane.

A priori, the length of the phloretin molecule raises the likelihood that activity might persist in the absence of one end or the other. But examination of assorted fragments from each end of the phloretin structure (the two columns of the upper section of Fig. 1) has revealed no agent of comparable potency; and the residual activity shown at higher concentrations appears to be independent of sugar concentration, so that it cannot be based on competition with the substrate. Moreover, when a combination of overlapping moieties (phloretic acid and phlorpropiophenone) was used, only a direct additivity of the separate inhibitory effects was observed, with no appreciable synergism. The much higher potency of the intact molecule thus focused attention on the orientation and spacing of the terminal groups. Simple α,ω-dihydroxyl derivatives of hydrocarbons of similar length (nonamethylene glycol or decamethylene glycol) were almost totally inactive; but among other diphenolic forms (lower section of Fig. 1), certain ones proved to be extremely potent in slowing sugar transfer.

The most effective inhibitor found was the synthetic estrogen, diethylstilbestrol; at physiological *p*H, it was about half again as potent as phloretin, while its saturated homologue, hexestrol (not quite so potent an estrogen) was some-

what weaker than phloretin. Since phloretin itself also shows definite estrogenic activity (*10*), some correlation of these two biological properties might be pursued. However, the related powerful estrogen dienestrol is relatively inert in the red cell system. Still less active is naringenin, which differs structurally from phloretin only in elimination of two hydrogen atoms, leading to assumption of the flavanone form given in Fig. 1. Some consistent structural distinction was therefore sought between these two rather inert materials and their active counterparts. In line with the implication of a two-point requirement as developed above, attention is called to the spacing of the terminal phenolic —OH groups. On the basis of either the Fisher-Hirschfelder-Taylor or the Catalin molecular models, all three of the especially active agents permit a center-to-center spacing of well over 13 A between the terminal hydroxyl O-atoms apposed to a flat surface. But with the two comparatively ineffective homologs this degree of separation cannot be achieved—in the case of naringenin, because of the shortening imposed by the internal bridge, and in the case of dienestrol because steric restraints make it necessary for the molecule to fold somewhat in bringing the terminal groups against a flat surface. In the same vein, it may be noted that the most active molecule, stilbestrol, is unique among the group in being held rather stiffly at full extension by reason of the double bond at the center.

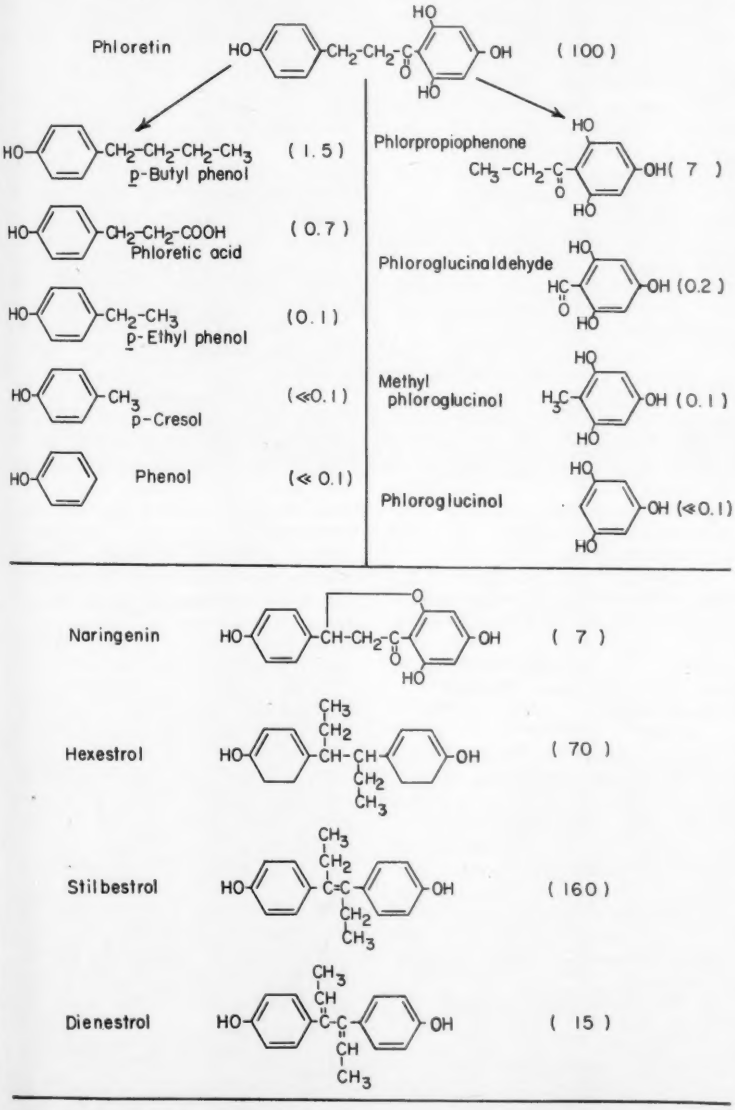

Fig. 1. Comparison of test agents as inhibitors of sugar transport through the surface of human red cells. Potency ratings in parentheses are reciprocals of approximate millimolarity at a level producing 50-percent inhibition in the test system described in the text.

It is therefore proposed that groups capable of reversibly binding or associating with phenolic —OH groups may be distributed in a recurrent spacing pattern over part, or all, of the red cell surface, and that the operation of the sugar-transfer system involves these same loci. The specially high potency of certain of the diphenolic agents would then be interpreted as deriving from the fact that their particular molecular geometry allows them to fix at two points on this matrix, with the corresponding large gain in tenacity familiar in the context of ion-exchange and chelation chemistry.

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16 February 1959

Letters

(Continued from page 66)

zations, like some college professors, that he is afraid to declare his loyalty.

The usual argument of those who so emotionally oppose the oaths is that their personal liberties are being threatened. Just what do they think is going to happen to their precious "personal liberties" if the communists continue to win the cold war? Name calling, such as speaking of "the stale aroma of McCarthyism," is not going to help our youth face the facts. When they fulfill their military obligations they will be taking the oaths and signing the affidavits. When they do the scientific work for the government for which they are to be trained at government expense—the purpose of this act—they will be taking the oaths and signing the affidavits! If they are unwilling to do so, it is best to find out now and not waste the taxpayers' money on them.

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Science and Public Education

There appeared in the 21 November 1958 issue of *Science* [**128**, 1290 (1958)] an advance notice, as it were, of a paper on Ice Age History, which was to be presented at the December meeting of the AAAS, by Richard J. Lougee, of Clark University, Worcester, Mass. The paper was obviously fantastic in its purported new concepts of ice age history and should not have found its way into the columns of *Science* without being referred to a geological authority. The claim that was made in the first paragraph, "that abundant new data have been collected at the department of geography of Clark University during the present International Geophysical Year" should have been enough to "flag" attention.

It did attract the attention of public-relations people, for press bureaus were waiting for the presentation of the paper to broadcast what they seem to have regarded as new vibrant scientific thoughts. Early the following week I arrived on the Pacific Coast and, in due time, friends handed me a clipping of a news article which had been taken from the Los Angeles *Times* of 27 December 1958, bearing a Washington date line of 26 December and prominently headed, "New Theory of Ice Age Presented." It contained the following lead: "A revolutionary new concept of the Ice Age today depicted one great glacier that temporarily buckled the upper United States to great depths."

Papers all over the country carried write-ups. The Washington *Post* of 27 December listed the paper on its front page as the number one feature of "yesterday's events in the sessions of the American Association for the Advancement of Science." The paper also carried on its first page an account written by a research professor of physics and a consultant to the National Science Foundation. In that, the physicist reported, "The theory demands a change in glaciological thinking as radical as that caused by Copernicus' theory that the earth is not the center of the universe."

Surely the prodigious labors of Chamberlin, Geikie, Leverett, and other pioneers of glacial geology and of the scores of workers today who have helped to build a formidable literature of monographs, professional papers, bulletins, and journal articles, confirming over and over again the verity of the doctrine of multiple glaciation, cannot be set aside by a writer's flight of imagination or by venturesome commentators.

It is evident that there is dire need for public education in science, but to be worth while, science must make its guidance effective. Specialization in geology has developed to such a degree that the untenability of the views entertained by Lougee would not necessarily be sensed by all geologists, let alone other scientists, and this emphasizes the need for correct handling.

It is my feeling that a disservice has been rendered to education and that the time has come for careful consideration of these matters.

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Leighton rightly says "the time has come for careful consideration of these matters." They attracted my attention in 1927 when, with Stuart Weller and L. C. Conant, I first observed iceberg-dropped Canadian granite erratics at Ozora, Mo.; last summer state geologist Sigurd Hansen of Denmark and I traced them northward into the Dakotas to elevations a thousand feet higher, at Pierre and Bismarck.

In 1954, Hansen and I mutually confided our belief that there is some basic misinterpretation of Ice Age history which is preventing normal correlations across the Atlantic, or even over short distances. Antevs estimates, from his studies of varved clay, that twice as much time has elapsed since the Ice Age as others have claimed on the basis of carbon-14 dates on supposed tills in the Middle West. To a few American geomorphologists, the glacial history of the Middle West and its "formidable literature" have long been suspect.

The trouble started in the days of Chamberlin, Geikie, and Leverett, in failure to recognize that certain widespread stony clays—which looked like bedded tills and sometimes contained perfectly preserved shells and black layers of organic matter—were deposits dropped by icebergs floating in open water, in the manner claimed by Sir Charles Lyell. Marine shelly drift of this sort reaches high elevations in British Columbia, as described and illustrated by J. E. Armstrong, and I have observed it blanketing portions of coastal Denmark, Sweden, Norway, and the British Isles, far above younger Yoldia shorelines.

On 29 April 1959, at the Naturalists' Forum of the Philadelphia Academy of Natural Sciences, I proposed the name "lyell" for these water-laid deposits, to distinguish them from till, which is spread by land ice. My type example of lyell is the Kansan-Illinoian complex, overspreading a true till, "Nebraskan," known to the north as "Wisconsin." It is apparent that many so-called tills on this continent—such as "Jersian," "Iowan," "Valders," "Toronto," "Cochrane", and "Vashon"—are lyells.

Twenty-five years ago I was instrumental in preventing a mass movement in geological thought toward a concept that claimed no unwarping in New England and retreat of thin stagnant ice from *north* to *south*! Using the clay-measuring and surveying techniques of DeGeer and J. W. Goldthwait, I found that the elevations of delta deposits, rising northward, show a history of immense crustal depression followed by intermittent upwarping as thick live ice melted away from *south* to *north*.

In the course of many years' association and field work with Leverett, Taylor, Upham, Hubbard, and D. H. Chapman, I found in the East that the earliest and greatest upwarping movement, "Hubbard uplift," commenced after 2000 years' crustal stability of Lake Hackensack and was followed in turn by 4000 years' stability of Lake Hitchcock, the latter coinciding with Maumee-Whittlesey stability in Great Lakes history. The discovery localities for Hubbard uplift are in Connecticut, but this uplift has now been impressively demonstrated in the Middle West, where the widespread submergence that preceded it has been mistaken for "multiple glaciations."

It is not my intention to combat all claims of multiple glaciations regardless of the region under consideration, but I hope to show that such claims are completely groundless in the classic localities in the Mississippi basin.

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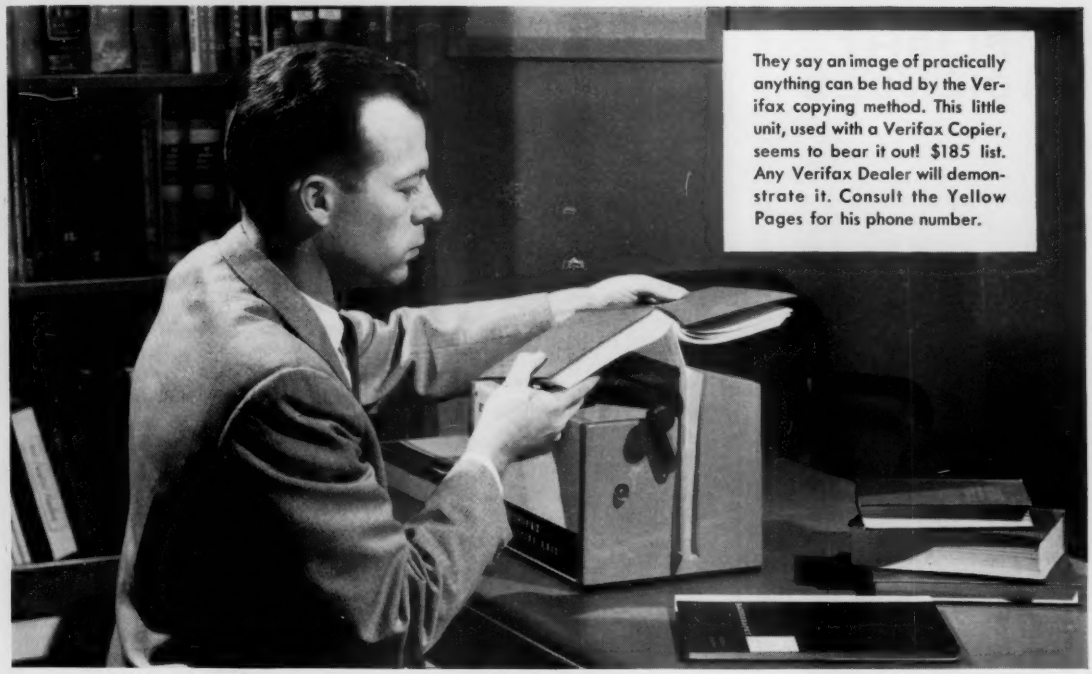
Kodak reports on:

copying as you go . . . items for EDTA to rob of color



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The chelatometrist and the gas chromatographer should be our friends

Though these lines were written on a chilly evening in April, they are very likely being read when it's too hot for tedious ruminations on chelatometry and gas chromatography. All we want to do is hop on the bandwagon, both bandwagons. Between the writing and the reading, Hahnemann Medical College & Hospital honored Chelation on May 6, 7, and 8 by a capital "C" and a symposium on "Metal-Binding in Medicine"; and many a laboratory which had no gas chromatograph in April had one by July. When these things pick up momentum, none dare stand in the way.

And why should we fear either of these powerful new passions that stir chemists?

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Meetings

Nuclear Optical Model

During the past two years the state of Florida, under the leadership of Governor Collins, has taken steps to build up nuclear science both at the University of Florida (Gainesville) and at Florida State University (Tallahassee). At Tallahassee preparations are being made for the installation of a tandem electrostatic accelerator and an electron accelerator. Both accelerators are being purchased by the state of Florida from the High Voltage Engineering Corporation.

An international conference on the "Nuclear Optical Model" was held in Tallahassee on 16–17 March 1959. This conference was organized by A. E. S. Green, who is primarily responsible for the initiation of the nuclear physics program at Tallahassee. In addition to its scientific purpose, the conference gave the visiting physicists an opportunity to learn of the plans of the nuclear physics group at Florida State.

Because of Green's extensive research on problems related to the bulk properties of nuclear matter, the choice of the topic of the conference was a natural one. In spite of the specialized nature of the topic, almost 100 nuclear physicists from many countries attended the meetings. Unfortunately, the physicists who had been invited from the U.S.S.R. did not come to the conference.

The optical model of the nucleus attempts to describe nuclear matter by assigning it properties which correspond, in the theory of light, to the refractive index and absorption coefficient of the medium. In nuclear physics one is not concerned with light waves but with the interaction of particles with nuclei. The quantity analogous to the wavelength of light is the wavelength of the particles, and the quantities analogous to the refractive index and absorption coefficients are the real and imaginary parts of the nuclear potential.

The optical model was first proposed to account for experiments on the interaction of neutrons with nuclei. These experiments had shown results which looked very much like interference and diffraction effects. At first, only qualitative fits were attempted, but more recently calculations have been performed to account for the experimental results quantitatively.

One of the sessions of the conference was concerned with the question of how well the experimental data could be fitted by optical-model calculations and of what detailed modifications of the potential had to be introduced. For example, the effect of variations of the depth of the nuclear potential at the nuclear surface and the effects of deviations of the shape of the nucleus from

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a sphere were discussed. In general, surprisingly good fits to the experiments were obtained, although there are still some experimental results which offer problems in fitting.

In another session the question of the foundation of the optical model was discussed. The model represents only a phenomenological description of the nuclear interactions and has to be justified in terms of more fundamental properties of nucleons.

An excellent summary was presented at the close of the conference by R. E. Peierls of Birmingham (England). Among Peierls' comments were the following: The detailed fits which are being attempted now with optical-model calculations go far beyond what had been contemplated when this model was first applied. Different authors may arrive at different parameters in fitting the same data, the variation depending upon the authors' philosophy—that is, upon how much variation with energy and atomic weight each is willing to allow in order to obtain detailed fits. So far the fits have not been capable of answering the important theoretical question of whether the absorptive part of the potential is peaked near the nuclear surface. It was surprising to learn that almost the same parameters could be used to fit the interaction of protons and neutrons with nuclei as are used to fit the interactions of composite projectiles such as deuterons and α-particles. One would have expected, for example, that a deuteron would have a very small chance of passing through a nucleus without breaking up. As a result, the absorptive part of the potential would have been expected to be much larger for deuterons than for nucleons.

The complete proceedings of the conference were prepared in the record time of a little over a month, and copies may be obtained by writing to Professor A. E. S. Green at Florida State University.

H. H. BARSCHALL
Department of Physics,
University of Wisconsin, Madison

Forthcoming Events

August

10–13. National Medical Assoc., Detroit, Mich. (J. T. Givens, 1108 Church St., Norfolk, Va.)

10–13. Society of Automotive Engineers, natl. West Coast meeting, Vancouver, B.C., Canada. (R. W. Crory, Meetings Operation Dept., SAE, 485 Lexington Ave., New York 17.)

16–19. Botanical Nomenclature, discussions (Intern. Bureau for Plant Taxonomy and Nomenclature), Montreal, Canada. (J. Rousseau, Natl. Museum, Ottawa, Canada.)

16–21. American Pharmaceutical As-

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soc., Cincinnati, Ohio. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

17. Ultrasonics, natl. symp., San Francisco, Calif. (L. G. Cumming, Inst. of Radio Engineers, 1 E. 79 St., New York 21.)

17–21. Pacific Southwest Assoc. of Chemistry Teachers, Pacific Grove, Calif. (W. A. Craig, 416 N. Citrus Ave., Los Angeles 36, Calif.)

17–22. Logopedics and Phoniatrics, 11th intern. cong., London, England. (Miss P. Carter, 46 Canonbury Square, London N.1, England.)

19–26. Refrigeration, 10th intern. cong., Copenhagen, Denmark. (M. Kondrup, Danish Natl. Committee, Intern. Congress of Refrigeration, P.O. Box 57, Roskilde, Denmark.)

19–29. Botanical Cong., 9th intern., Montreal, Canada. (C. Frankton, Secretary-General, 9th Intern. Botanical Cong., Science Service Bldg., Ottawa, Ontario, Canada.)

19–29. International Assoc. of Wood Anatomists, Montreal, Canada. (IAWA, Laboratorium für Holzforschung E.T.H. Universitatstrasse 2, Zurich, Switzerland.)

19–29. Mycological Soc. of America, Montreal, Canada. (E. S. Beneke, Dept. of Botany and Plant Pathology, Michigan State Univ., E. Lansing.)

19–29. Phycological Soc. of America, Montreal, Canada. (W. A. Daily, Dept. of Botany, Butler Univ., Indianapolis 7, Ind.)

20–22. Rocky Mountain Radiological Soc., Denver, Colo. (J. H. Freed, 4200 E. Ninth Ave., Denver 20.)

20–25. Chemical Thermodynamics, symp., Wattens, Austria. (F. Vorländer, Deutsche Bunsen-Gesellschaft, Carl-Bosh-Haus, Varrentrappstrasse, 40–42, Frankfort a.M., Germany.)

20–27. Therapeutics, symp., Gardone, Italy. (R. Morf, c/o Sandoz S.A., Basel 13, Switzerland.)

20–2. Limnological Cong., 14th intern., Vienna and Salzburg, Austria. (Secretary, 14th Intern. Limnological Congress, Biologische Station, Lunz am See, Austria.)

23–26. American Farm Economic Assoc., Ithaca, N.Y. (C. D. Kearl, Dept. of Agricultural Economics, Warren Hall, Cornell Univ., Ithaca.)

23–27. Veterinary Medicine, 3rd Pan-American Cong., Kansas City, Mo. (B. D. Blood, Pan-American Congresses of Veterinary Medicine, P.O. Box 99, Azul, Buenos Aires Province, Argentina.)

24–26. American Accounting Assoc., Boulder, Colo. (C. Cox, 437 Hagerty Hall, Ohio State Univ., Columbus 10.)

24–26. Anti-Submarine Warfare (classified), symp., San Diego, Calif. (R. R. Dexter, Inst. of the Aeronautical Sciences, 2 E. 64 St., New York 21.)

24–26. Dynamics of Conducting Fluids, symp. (American Rocket Soc. and Northwestern Univ.), Evanston, Ill., (J. J. Harford, ARS, 500 Fifth Ave., New York 36.)

24–27. American Hospital Assoc., New York, N.Y. (E. L. Crosby, 18 E. Division St., Chicago, Ill.)

24–28. Australian and New Zealand Assoc. for the Advancement of Science, 34th cong., Perth, Western Australia. (J. R. A. McMillan, Science House, 157 Gloucester St., Sydney, Australia.)

24–29. Infrared Spectroscopy Inst., 10th annual, Nashville, Tenn. (N. Fuson, Director, Infrared Spectroscopy, Fisk Univ., Nashville 8.)

24–29. International Assoc. for Hydraulic Research, cong., Montreal, Canada. (IAHR, c/o Laboratoire Hydraulique, Raam 61, Delft, Netherlands.)

24–29. Ionization Phenomena in Gases, 4th intern. conf., Upsala, Sweden. (A. Nilsson, Secretary-General, Inst. of Physics, Upsala, Sweden.)

24–29. Polarography, 2nd intern. cong., Cambridge, England. (Mrs. B. Lamb, Chemistry Lab., Evershed & Vignoles, Corner of Iveagh Ave., N. Circular Rd., London N.W.10, England.)

24–30. Modern Systems for Detecting and Evaluating Optical Radiation (Intern. Optical Commission), symp., Stockholm, Sweden. (S. S. Ballard, Dept. of Physics, Univ. of Florida, Gainesville.)

25–27. Petroleum Industry Conf., AIEE, Long Beach, Calif. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

25–28. Alaskan Science Conf., Alaskan Div., AAAS, 10th, Juneau. (N. J. Wilimovsky, Bur. of Commercial Fisheries, Box 2021, Juneau.)

25–28. American Dietetic Assoc., 42nd annual, Los Angeles, Calif. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

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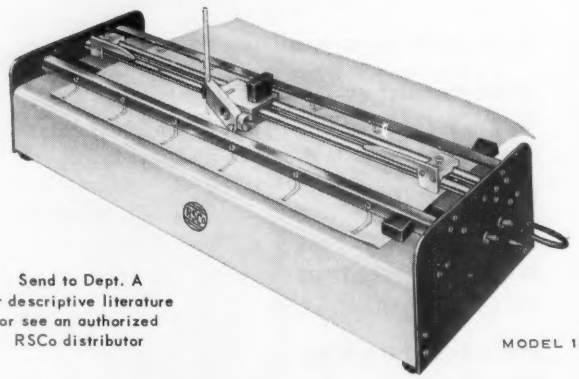

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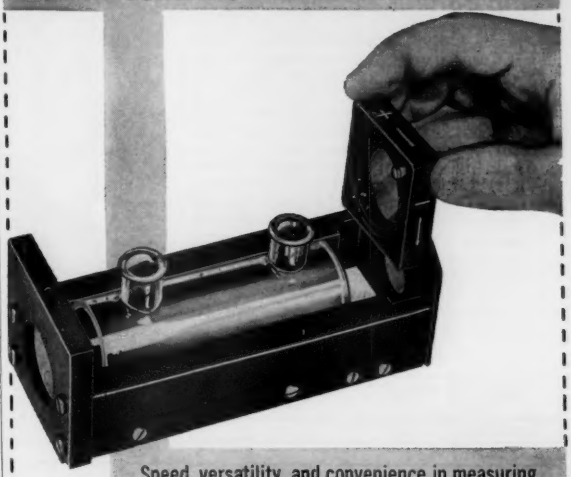

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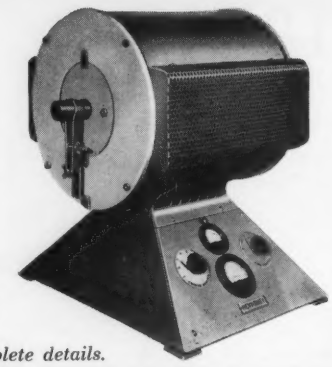

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25–30. American Ornithologists' Union, Regina, Saskatchewan, Canada. (H. G. Deignan, Div. of Birds, U.S. National Museum, Washington 25.)

26–29. International Assoc. of Milk and Food Sanitarians, Glenwood Springs, Colo. (V. T. Foley, Health Dept., Kansas City, Mo.)

26–29. International Union of Pure and Applied Chemistry, 20th conf., Munich, Germany. (Div. of Chemistry and Chemical Technology, Natl. Research Council, Washington 25.)

27–29. American Assoc., of Clinical Chemists, 11th annual, Cleveland, Ohio. (A. Hainline, Jr., AACC, Cleveland Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

27–29. American Physical Soc., Hawaii. (K. K. Darrow, APS, Columbia Univ., New York 27.)

28–29. Weather Modification (with American Soc. of Civil Engineers), conf., Denver, Colo. (H. G. Houghton, AMS, Dept. of Meteorology, Massachusetts Inst. of Technology, Cambridge 39, Mass.)

28–30. American Folklore Soc., annual, Albany and Cooperstown, N.Y. (MacE. Leach, 110 Bennett Hall, Univ. of Pennsylvania, Philadelphia 4.)

28–31. Astronomical League, Denver, Colo. (R. Dakin, 720 Pittsford-Victor Rd., Pittsford, N.Y.)

28–4. International Union for Scientific Study of Population, cong., Vienna, Austria. (F. Lorimer, Dept. of Sociology, American Univ., Washington, D.C.)

30–3. American Inst. of Biological Sciences, annual, University Park, Pa. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

30–4. American Cong. of Physical Medicine and Rehabilitation, Minneapolis, Minn. (Miss D. C. Augustin, 30 W Michigan Ave., Chicago 2, Ill.)

30–4. Laurentian Hormone Conf., Mont Tremblant, Quebec, Canada. (G. Pincus, 222 Maple Ave., Shrewsbury, Mass.)

30–4. Medical Education, 2nd world conf., Chicago, Ill. (World Medical Assoc., 10 Columbus Circle, New York 19.)

30–5. World Federation for Mental Health, 12th annual, Barcelona, Spain. (Miss E. M. Thornton, Secretary-General, WFMH, 19, Manchester St., London W.1, England.)

30–6. History of Science, 9th intern. cong., Barcelona and Madrid, Spain. (J. Vernet, via Layetona 141, Barcelona.)

30–6. Residues on Crops and/or the Problem of Insect Resistance to Insecticides, symp., Munich, Germany. (R. Morf, Secretary-General, IUPAC, c/o Sandoz, S. A., Basel, Switzerland.)

31–3. Biological Photographic Assoc., Montreal, Canada. (Miss J. H. Waters, P.O. Box 1668, Grand Central Station, New York 17.)

31–3. Mathematical Assoc. of America, 40th summer meeting, Salt Lake City, Utah. (H. M. Gehman, MAA, Univ. of Buffalo, Buffalo 14, N.Y.)

31–4. Haematin Enzymes, symp. (by invitation), Canberra, Australia. (A. H. Ennar, John Curtin School of Medical Research, Australian National Univ., Canberra.)

(See issue of 19 June for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable, and it reflects the claims of the manufacturer or other source. Neither Science *nor the writer assumes responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 118.*

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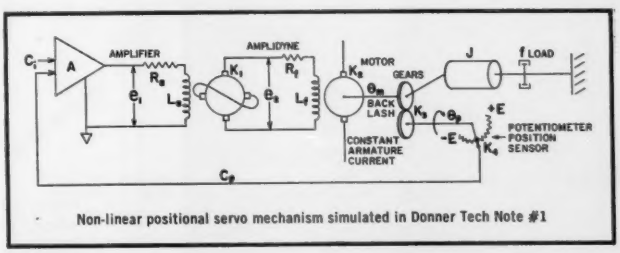

Non-linear positional servo mechanism simulated in Donner Tech Note #1

By simulating the system on the computer, the designer can examine system performance under the influence of every parameter. Changing constants and observing changes in response gives the designer a feel for the system impossible with a strict analytical approach.

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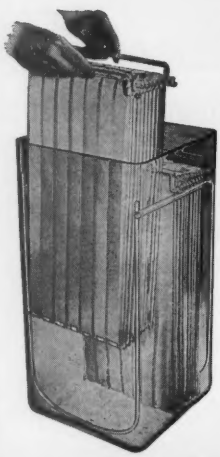

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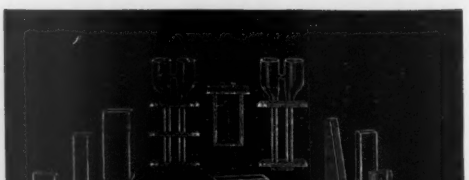

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■ STRAIN INDICATOR is said to provide resolution ±0.005 percent, linearity 0.02 percent, repeatability ±0.01 percent, and absolute accuracy ±0.05 percent for calibration and linearity testing of strain-gage transducers. Accuracy is independent of input and output impedance over the range 60 to 1000 ohm. Calibration is adjustable from 1 to 15 mv/v. Direct-current power to the transducer is regulated and adjustable between 5 and 15 v. (Baytrex Corp., Dept. 914)

■ ULTRASONIC DELAY LINES will store a signal with minimum attenuation for periods ranging from less than 50 to more than 15,000 μsec. The short-delay lines are constructed of glass with nearly zero temperature coefficient of delay. The very-long-delay lines are of fused silica formed into plates up to 48 in. in diameter. (Corning Glass Works, Dept. 917)

■ CHROMATOGRAPH uses argon as carrier gas and an ionization detector for detection of components. Detection depends upon the increase of ionization current that occurs when organic vapors enter the ionization chamber. Increase of sensitivity over thermal detection methods of 100,000 times is claimed. Range of sensitivity is 2×10^6 to 2×10^3 parts of carrier gas for full-scale deflection. Limit of detection is 10^{-11} mole. (Jarrell-Ash Co., Dept. 918)

■ CHART MARKER mounts on strip chart recorder and prints an identifying number, 0 through 9, each time its solenoid is energized. The single print wheel of the device advances one number automatically after each print-out, returning to 0 after 9. The device operates on 115 v a-c. (Royson Engineering Co., Dept. 919)

■ PLOTTER converts information on IBM punched cards into visual plotted form. The device operates from an IBM card reader and will plot 400 graphs with 4000 points in less than 2 hours. Data points are printed with numbers to separate and identify curves. (Gilmore Industries Inc., Dept. 924)

■ VACUUM GAGE of thermal-conductivity type is sensitive in two ranges from 1 to 100 μ and from 1 μ to 500 mm. The instrument uses a magnetic-type amplifier. A built-in circuit, adjustable to operate anywhere within the pressure range of the instrument, may be used as a protective switch for the vacuum system. Signal output for recorder operation is provided. (Consolidated Electrodynamics Corp., Dept. 926)

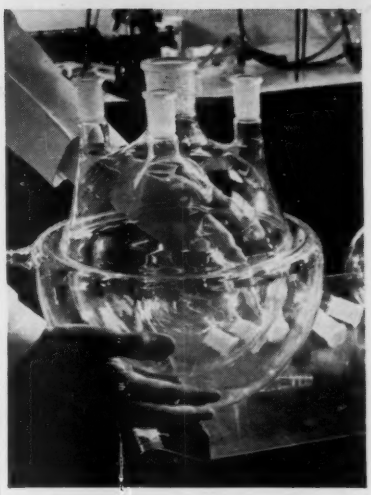
■ MONOCHROMATIC LIGHT SOURCE for optical interferometric inspection of surfaces is portable and self-contained in a carrying case. Observations are made by placing the surface to be inspected on a 10-inch flat fixed in position in the illuminator and viewing the underside of the flat through a mirror. (Cartriseal Corp., Dept. 921)

■ GALVANOMETER AMPLIFIER is a six-channel, three-stage, transistor d-c amplifier with overload protection at both input and output to eliminate transistor damage and galvanometer burn-out. Each of the six channels is isolated from ground by individual floating power supplies. Voltage gain is adjustable from 0 to 1. Output into a 37-ohm load is ±2.4 v at 65 ma from d-c to 8 kcy/sec. Noise is less than 3 mv peak-to-peak, and drift is less than 3 mv/°F. (Minneapolis-Honeywell, Dept. 920)

■ MICROTOME for metallographic specimens provides automatic advance in steps for 10, 20, or 30 μ for preliminary surfacing after which final preparation is accomplished in steps of 2 to 4 μ. Contact between knife and specimen on the return stroke is avoided by lowering of the specimen. Fine knife tracks are eliminated by electrolytic lap polishing or other means. Speed of cutting is continuously adjustable. Preparation of a sample generally requires 4 to 6 min. (William J. Hacker and Co., Inc., Dept. 927)

■ PROCESS ANALYZER operates by detecting refractive-index differences between a process stream and a reference sample. The instrument is a null type designed for continuous operation. An electric or a pneumatic controller can be provided. A range extension feature allows suppression up to 10 times the standard range without initial zero shift or change of reference solution. The analyzer can be furnished with a mass or volume collecting system which replaces the synchronous chart drive on the recorder and permits plotting refractive index change relative to mass of sample passed. (Phoenix Precision Instrument Co., Dept. S925)

JOSHUA STERN
National Bureau of Standards, Washington, D.C.



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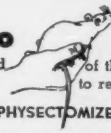

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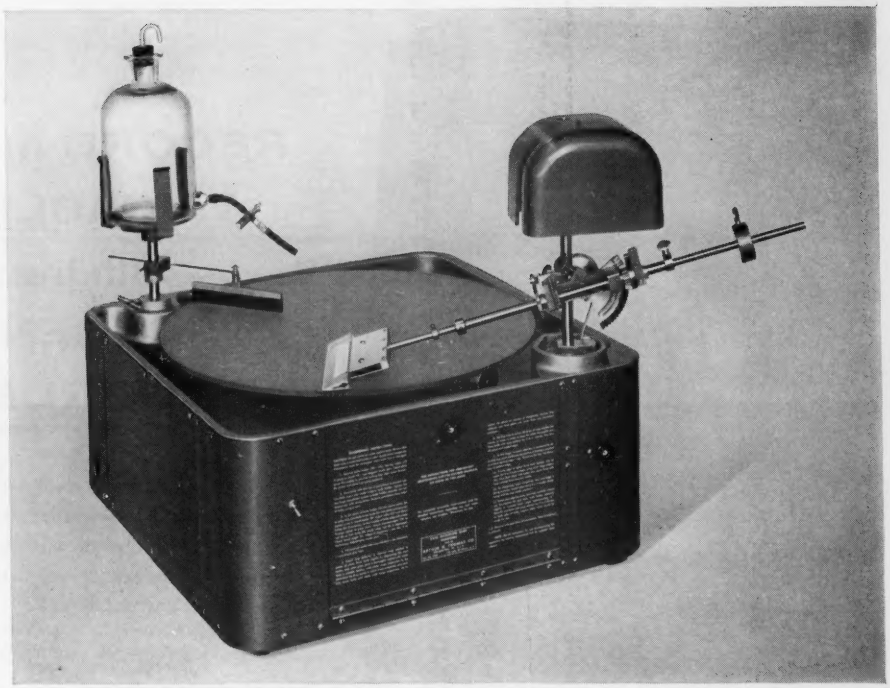

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